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*PAPERS ON THE GEOLOGY OF NEW MEXICO.

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The following pages are derived from the results of studies carried on at intervals during four years. Several articles in the American Geologist have discussed certain features of the geology of the territory and may be considered to form a part of the present series. The enormous area over which these investigations must extend before they can approach completeness and the interrupted course of the field work unite to prevent any symmetrical prosecution or publication of the work. It has seemed best therefore to print the results in sections covering definite areas more or less cursorily and to leave the task of correlating the data to a later period. These articles then do not presume a knowledge of the geology of the territory at large, as they ought to do in order to be complete, but are materials toward a more synthetic study in the future. It is hoped that this method of publication will serve a good purpose in stimulating further work and in aiding in the practical development of the region.

I.

THE GEOLOGY OF THE SOCORRO MOUNTAIN.

With Plates IX, X and XI.

Probably nowhere in the territory can more suggestive geological data be found in so limited a space as in the small group of mountains lying immediately west of the town of Socorro and bearing that name. The mountain front at the north is prominent and precipitous, while the eastern face is elsewhere broken by intersecting canons and depressions. We here have in epitome the geological history of the entire region. The stratified rocks are represented by a few hundred feet of the lower portion of the Carboniferous limestones with the subja-

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cent quartzite. This series, which must at one time have been continuous with the same formation in the Magdalena region to the west, the Limitar region to the north and the Sandia, Manzana region to the north-east, is here exposed only as a mere fragment in the side of the mountain-escarpment, where its upturned edge is exposed as it dips into the mountain, that is, to the west. Small as is the extent, the exposure is a good one and has afforded a large number of fossils. Near the bottom is the horizon of Productus cora and Spirifer opimus. The section at this place is as follows:

The limestone is capped by flows of brecciated material that speak of explosive volcanic activity. These flows are of trachytic nature but are not the first of the volcanic outbursts to which the mountain owes its origin. The trachyte rears its head to the height of 8000 feet in the form of a high promentory from which a sharp ridge extends westward for over a mile, forming the northern wall of an ancient crater of great extent. The flows from the crater have extended to the northward in descending cascades and gentle streams to the point where the range is abruptly cleft by the Nogal canon. To the north still was another trachyte volcano which has left a mighty spur known far and wide as strawberry Peak. This volcano also had its period of tremendous explosive outbreak as is shown by the great mass of breccia and talus-conglomerate collected in the region to the northeast and laid open by a second canon to the north of Nogal canon.

Even in the amphitheatre of what we take to be the seat of the old trachyte volcano are here and there similar deposits, especially towards the north-east and south-east sides. These breccias and talus conglomerates yield on erosion most fantastic and architectural forms and the castellated peaks and odd mural shapes are characteristic of the deposits. Plate X, from the south side of the great crater-like area refered to and on the south side of the Blue Canon road, gives an idea of the conditions. As already said, the trachyte period was not the earliest stage of eruptive activity. The proof of this assertion is found in certain obscure but important masses of andestite found usu-

ally under the later flows. The limestone did not extend south of the principal Socorro peak but is abruptly cut off by a dark mass of andesite. The andesite projects beneath the trachyte and rhyolite of the mountain and has been entered by a number of mining tunnels, notably that of the Merritt mine which has produced at various times considerable silver and gold. Small rich bits of gold-bearing rock are encountered from time to time, though the miners have hardly yet learned that it is derived from the andesite contact alone. To the south the deep cleft known as Blue Canon has cut into the trachyte crater and in so doing has laid bare the andesite to a considerable extent and here we encounter exposures of the unaltered rock so like in its section to the diabase porphyrite of the lake Superior region as to be indistinguishable. Where ever the acid rocks have come in direct contact with the andesite in a state of fluidity and with thickness enough to permit of metamorphism there seems to have been some segregation of ore. In other cases, where the two have been left in juxtaposition and where water has access to the contact there has been extensive kaolinization of the andesite and a certain amount of similar decomposition of the acid rock also. These beds of kaolin which are used in the clay works of Socorro are very instructive as illustrating the effects of interaction of the two rocks even without heat as a factor. The mines of the Socorro mountain are also cases in point in proof of the thesis elsewhere maintained that the segregation of gold and silver ores is closely associated with a particular kind of metamorphism between basic and acid rocks.

The western boundary of the trachyte area is formed by a series of mountains terminating in a single abrupt conical hill of trachyte which we have designated as "pyramid mountain" and which is skirted on the south by the new Blue Canon road. To the west the whole northern part of the range is composed of granite or gneiss. The axis of the main ridge running east and west is nearly as high as Socorro mountain proper and the contact with the trachyte is sharp with some traces of metamorphism but no definite evidence as to the sequence. It may be presumed that the granite outpour was cotemporaneous with

that of the trachyte. It may be suggested that the granite is due to metamorphism of preexisting sedimentary rocks fused by the action of the immense volcano. In this case, as in all others of this portion of the territory, the trachyte flows were followed by others of a still more acid nature. . It would seem that these latter flows were not so much from the crater as along a great irregular fissure extending south from the vent. A series of waves of such material forming quartz trachyte and rhyolite form the abrupt range facing the river and extending four or five miles southward from Socorro mountain proper. The foot hills are all of talus conglomerate with boulders of various sizes up to 18 inches or two feet in diameter. Appearances seem to show that at this time the surrounding region was under water. Toward the south end of this series a considerable flow of white obsidian is found and obsidian sheets cover poorly cemented detrital material of the same age. The most prominent of the hills of the trachyte series lies west of the smelter settlement known as Park City and from the west affords an abrupt front with basaltiform columns. We have called it Pallisade mountain. Plate XI, Fig. 1. Pallisade mountain from the northwest showing recent strata at 3. The foreground (4) is a granite hill over which the Blue Canon road passes. To the southward a spur passes for a mile or more at a low elevation toward the Magdalena rail road. This projection offers an opportunity for the study of alteration phenomena, of which more beyond. In the south-eastern part of the area no evidence of the oldest or andesite period is revealed but in the south-western angle at Clemou an aphanitic phase of the basic eruptive is left uncovered by the basalt that covers the south-west one fourth of the quadrangle and has been eroded by the arroyo as well as cut by the railroad. Here too is evidence of explosive activity in the form of masses of talus conglomerate (See Plate XI, Fig. 2). 1. Talus conglomerate. 2. basis eruptive. 3. Magdalena Mountains in distance.

The south-west quarter of the area under consideration, as already hinted, is covered with a flow of dark basalt of an average thickness of not more than twenty-five feet which, near

the margins, is reduced to five. The area over which this flow is undisturbed is only a fraction of the whole but in a large part of the area there has been extensive undermining of the soft material upon which the lava reposes. Thus the mile or more intervening between the lava sheet and Pallisade mountain has been transformed into a desperate kind of *mal pais* in which the large fragments of lava are upturned in all directions, making it practically impassible. The source of the flow is apparently at a point at present separated from the main sheet, to the west of the "Cactus Plain" through which the rail road passes to Magdalena. The region of "Indian Hill" is also a portion of this flow. In a deep canon in the last mentioned series of hills deeper parts of the flow, apparently in the channel of outlet, are exposed and here the nature of the rock is different from the superficial portions as elsewhere described. From this region the lava seems to have spread to the north and east but it has been removed wholly in the valley of the stream that in wet times skirts the western border of the Socorro mountain region as well as over broad valley intersecting that range from the middle of its western margin and forming the southern boundary of the granite area. The history of the region from the end of the rhyolite period to the overflow of lava, so far as it is recorded, is preserved in a loose fragmental series the materials of which are apparently derived from the adjacent rocks. This is well exposed in the south-eastern part of the region where are a variety of lava-topped cliffs beneath which are sandstones and crags probably of quite recent origin. The flow extended for some distance north along the eastern face of the range and has left outliers in the form of lava-topped buttes of which the most conspicuous is near the springs which supply the city of Socorro with water. The underlying formation is here very largely derived from fragments evidently worn out of the earlier talus conglomerates. In the depressed area in the center of the region here under consideration, at the western foot of the Pallisade mountain, are remnants of the same horizontal strata Plate XI, Fig. 3, and their continuation below the large lava sheet to the west and south-west is easy to follow. These soft

strata are easily undermined and as they are removed by percolating water the lava above breaks into irregular fragments under its own weight and ultimately these fragments are indiscriminately dropped into the space beneath.

To the north-east, nearly directly east of the peak known as Strawberry there is an extensive series of sandstone and shales some of which are full of gypsum fragments; these are often tilted, dipping toward the range, i. e. to the west. No fossils have been found and it is at present impossible to tell whether they are of Cretaceous age as the gypsum might suggest, or whether they are of the same age as the other loosely aggregated material of the region farther south. Near the base of the range there are a number of ancient basaltic dykes which bear intrinsic evidence of a greater age than those forming the surface flows. They are interbedded and we cannot say from the exposures seen whether they have been intercallated in the series before the disturbance or whether they too were at one time surface flows, and since that time have been imprisoned under later sediments.

Plate XI, Fig. 3. Panoramic view of the Socorro Mountains from the east, from a series of photographs, as seen from the city of Socorro. The numbers are placed with reference to sources of the rocks examined and will be referred to in the section on petrography. 1. Strawberry Peak; 2. Socorro Peak, between this and 1, Nogal Canon; 3. Promontory Peak; 4. Sharp Peak, north of which a dyke cuts off the limestone seen at 22; 5. similar small peak near which gold discovery has been made; 6. western granitic part of main range; 7. The upper and western of two flows of quartz trachyte flowing over andesite at 27; 8. western wall of the old crater about one mile west of 7; 9. hill forming southern wall of Blue Canon, the lower part of andesite, upper of trachyte and rhyolite; 10 to 13. various trachyte, rhyolite and breccia flows; 14. Pallisade Mountain; 15 to 19. hills of stratified gravel and sand covered with a thin flow of recent basalt; 20. flow of trachytic rock over the limestone; 21. quartzite at base of limestone; 22. Carboniferous limestone, about 400 feet thick; 24 to 26. ande-

site beneath the trachyte, Merritt and other mines; 26. beds of kaolin from decomposition of andesite and trachyte; 29. Blue Canon; 30. Rio Grande smelter; 31. spring; 32. spring and mill; 33. ranch; 34. clay.

2.

THE LIMITAR VOLCANO.

Limitar mountain is a member of the range bordering the Rio Grande on the west that lies north of the Socorro mountains. The interval between them is filled with lower ridges of the same materials as are seen in the main mountains, chiefly trachyte flows probably from fissures in the of axis upheaval. The stratified rocks are less disturbed. This mountain is about five mills from the river and directly west of the town by the same name so that it is easily visible from the Santa Fé rail road. It may be distinguished by the oblique band formed by a section of tilted limestone laid bare during a late explosion of the volcano. Between the river and the base is a series of sandstones and crags which may be of Pleistocene age or recent, while nearer the base are what may prove to be remnants of Cretaceous sands and shales with a sharp dip to the west and interbedded with ancient basalts. It would appear, however, that the later fragmental series is only mediately related to the eruptives which furnished their materials, for at the foot of the cores of eruption we generally find a different class of fragmentals. In the early history of our volcano, as well as at intervals subsequently, there were periods of explosive activity or else the products of eruption were cast, while still hot into the sea, there to be shaken up violently and detonated by the sudden cooling. There is evidence that both of these methods of comminuting the flows were in vogue at different times. Thus in some cases the resulting product is a coarse breccia with angular fragments and a very small amount of sand in the interstices, while in other cases, the binding material is of the substance of the flow which has caught up the exploded fragments in its course. Some are veritable talus-conglomerates within or near the crater itself, while others are but the selvages of anarachactic or narrow in-

trusive flows. It is also quite the rule in this as in other similar regions that the massive flows should catch up fragments of the adjacent or perforated country rock and incorporate them more or less completely in the pasty or fluid magma. It then, of course, follows that these fragments are themselves more or less altered while, if the heat was sufficient, the magma is likewise modified by the introduction into it, at various stages of cooling, foreign ingredients. In fact, nature has here performed for us some of the most difficult experiments feebly attempted in modern laboratories of synthetic geology and the study of the alteration phenomena both chemical and physical occurring in the rock fragments and in the "symmorphic" result of the integration of the various disparite elements by secondary fusion promises more for this branch of geology than any method available and yet, curiously enough seems hardly at all worked.[1]

We may picture to ourselves a time when the Cretaceous strata lay in practically undisturbed possession of the region. The time was long past when coal swamps occupied the great basins to the west and south-east and gradual elevations alternating for many years with slight depressions had afforded the conditions necessary to the formation of beds of gypsum and salt.[2] We may suppose that a long period of elevation had passed over the region without leaving any record except in extensive denudation and an occasional local deposit. There were doubtless secular contractions of the crust but at last a time came when the intrinsic strains overcame the rigidity of the crust and great orographic lines of weakness developed in approximately prrallel lines extending north and south over the whole area of the southern Rockies. The present course of the Rio Grande in central New Mexico occupies what may once have been the axis of such a fold, while the intersection of the western declevity with the present general level is marked by

[1] Cf. Endlich, On the erupted rocks of Colorado. Hayden Survey Report for 1876.

[2] Salt springs occur only a few miles north-west of the Limitars and cause the waters of the Rio Salado to be decidedly salt to the taste.

a fracture zone in which lie the chief centres of overflow. Elsewhere the greater igneous activity is on the eastern side though just what the determining circumstances were we are as yet unable to say. It is a well-known aphorism that the crests of greatest elevation, by reason of greater fracture and superior accessibility, become sooner or later the depressions and, *ceteris paribus*, the courses of the streams. Our area is no exception and the moutain ranges of the west bank of the river are considered to be secondary in the sense that they are, in part, the remnants left by erosion from the original uplift. To the preservation of these ridges the frequent and often extensive outpour of eruptive rocks has greatly contributed. At first it might seem that the vent for such overflows should have developed in the axis of the fold but the analogies as well as a variety of theoretical considerations reinforce the other view and sustain the evidence from the field. Thus the shear strains and the thickening and heat increment would be greatest near the sides at the base and the isogeotherms would accordingly be elevated at this place.[1] There is much reason to suppose that the materials of the eruptives are essentially of local origin, in fact that they are derived from the fusion of materials lying at no great depth beneath the site in which they now occur. The agencies of metamorphism being then greatest at the sides near the base and the techtonic strains there having a maximum it follows that the lower portion of the strata are there fused, the support for the rest is removed as a result, there is a faulting of the whole, causing the tilting of the series toward the axis of weakening on the "down" (here western) side and an outpour of fused material at the same time. If the thrust and outflow were violent there would be a second fault of the same sort to the west. This has apparently been the history of our region. The limestone occupying the upper part of the series is relatively infusible while the subjacent acid rocks consisting of sandstone and conglomerate was readily altered—in some cases

[1] Hot springs and secular vibrations still attest the elevation of the isogeotherms in this belt.

to the point of complete fusion. The result has been local thickening of the acid rocks and their conversion into quartzites, hornblendic schists, gneisses and finally granite. This last stage in the metamorphism has been attained by the old sedimentaries in the Limitar range proper while to the north and south the place immediately below the lime is occupied by hornblendic schists with gneissic bands and veins of diorite. Passing south to the next centre of eruption (in the Socorros) the rock is simply a quartzite. At various times the theory has been advanced that granite is properly speaking always protogene and consequently that a metamorphic origin is impossible. But aside from the strong testimony from analogy in the present case, there occurs about half way from the base of the Limitar to the lower surface of the lime a band of limestone included in the granite. This band is about eighteen inches wide and contains, in spite of high metamorphism, some fossil remains, proving conclusively the sedimentary nature of the beds from which the granite has been derived. Below, the granite passes into gneiss and this into hornblendic schist both the latter being broken by diorite. The writer has attempted to show on the basis of the conditions on the north shore of lake Superior, that diorite is essentially paragenetic and not an independent intrusive. The evidence of the region in question is strongly in favor of this conclusion for the diorites all assimilate closely to the gneisses in which they solely occur.

Seen from the south, our volcano appears as a broad-based cone from which skeleton ridges extend to the north-west and south. The entire eastern base is composed of the acid series just described, most characteristic being the red coarse granite with large quartz grains and sparsely and crudely mingled hornblende. Even at a great distance from the south one can detect the broad light stripe of obliquely tilted limestone where it is exposed by some vast eruptive outburst which not only tore open the very vitals of the mountain but plowed an enormous furrow across the lime and thus made good its escape to the south and east. Little is left to show of this flow but the eroded edge of the lime to the north and the tilted and scattered

fragments in the hills to the south of the canon formed by it. In the amphitheatre-shaped cavity on the southern slope of the cone there is exposed a portion of a granite lying quite near the heart of original eruption, while above it are the brecciated fragments of the explosive phase of the eruption. The limestone dips into the crater cone at an angle of over 30 degrees and a part of its upper surface was left bare by the out-burst. Farther north, however, we find a spot where the original flow spread out over the lime. Here, in fact, was the theatre of a curious activity. It appears from examination of the fragments contained in this brecciated flow that the lava was essentially an andesite but where it came in contact with the lime a double interchange was affected. In spite of its great infusibility, the upper part of the lime was crystallized, forming a bed of calcite with cherty lammellae. On the other hand, the igneous rock was minutely subdivided and the fragments included in calcite from the lime. The resulting rock almost defies classification. The fragments which may be single crystals of the original rock or small fragments with numerous crystals, are greatly corroded also. About three hundred feet of this tuff overly the limestone. So far as appears from the east, the next step might have been the final one in the active history of the volcano, for the upper three to four hundred feet up to the cones and craters on top is covered with a vast sheet of rhyolite with free quartz which is more or less plainly visible to the eye. Passing now to the summit, the attention is held by a remarkable panorama. Evidently the axis of eruption rather closely correspond with the line of fault and so the declivity is very steep—in places almost sheer several hundred feet to a narrow valley which plainly displays on the opposite slope the up-tilted edge of the limestone in a fault entirely similar to the one which we have just past. Above it still to the westward is a series of hills of rhyolite springing from the fracture on the down throw side. But as we descend the ridge we discover much of buried history. The rhyolite which was the last phase of eruption did not follow directly the explosive stage represented by the andesite tuff but, probably after a period of repose, there had been more than one outflow

of trachyte and trachyte pitchstone. These flows extend throughout the valley and to the south are seen underlying minor rhyolite masses. From the plagioclase-bearing and quartzless andesite to the acid rhyolite was a long step but this is partly bridged by the trachyte interval showing that mountains may grow old gradually if not gracefully. But there have been other episodes in the history we seek to follow. The crater during trachyte time must have been near its present site for a great boss of brown trachyte pitchstone still rears it head to the southwest of the crater never having been quite concealed by the flows of rhyolite. To the south of this peak the rugged vertebral column of the range is transversely cut by a dark dyke of small dimensions which, though greatly altered may have been andesite. Its strike suggests that it may have been derived from the great boss protruding from the western face. This rock compromises matters by leaving out the feldspars entirely and may be called a magma basalt or limburgite. It thus appears that the mountain made sundry attempts to restore its youth but its hoary summits attest the victory of the acid series.

At the very summit just south of the highest peak is an oval crater walled on all sides. Its longer axis is about 400 feet long and extends south east, while the shorter diameter of the ellipse is 250 feet measuring in both cases across the top. To the north east of the highest peak is another depression of a crescentic form which probably is also an old crater.

Now passing west to the opposite side of the valley we encounter the same sequence of limestone and shale strata as that on the eastern side of the main range. Near the bottom is a shaley stratum which is quite fossiliferous. Some little distance above this horizon is another of perhaps twenty-five feet with still larger fauna. As we ascend the evidences of life are less profuse being chiefly corals of which massive reefs occur at various horizons. Toward the top the evidences of metamorphism increase till the top becomes compact flint. There is no such interpenetration of the superincumbent rock as in the corresponding situation on the eastern side for the flow is a brown

rhyolite. The latter rises to the height of several hundred feet above the top of the lime only to drop away rapidly to the west. At a point some two or three miles further south a section across the axis above desribed indicates that there was much less of igneous outpour but the disturbance is particularly well shown as also the metamorphism of the acid member. The diagram (Plate XI, Fig. 5) illustrates the situation.

Ideal Section through the axis of uplift south of Limitar mountain. 1. Trachyte crater. 2. Laminated margin of trachyte. 3. Porphyry about the margins. 4. Brecciated contact zone. 5. Massive limestone. 6. Shale with Productus cora. 7. Quartzite (20 feet). 8. Shaly limestone with Spirifer camerata. 9. Quartzite passing into the next. 10. Mica and hornblende schist with quartzite bands and phases. 11. Granite. 13. Diorite intrusive (paramorphic). 14. Talus conglomerate in or near the crater.

3.

MOUNT MAGDALENA AND THE BASIC ERUPTIVES OF THE MAGDALENA DISTRICT.

With Plate XII.

The general geological conditions of the Magdalena mountains formed the subject of an earlier paper to which reference is made throughout the following paragraphs.[1] The present paper is devoted to an area immediately adjoining the range on the north and west. It will be recalled that the Magdalena mountains form a compact range extending nearly north and south for a distance of about twenty-five miles and separated from the Rio Grande at the north by the Socorro range. The distance from the river is from fifteen to twenty miles. The mountains rise rather abruptly from the plain some three thousand feet or to the elevation of ten thousand feet above tide. Its northern portion is formed along a fault line extending from

[1] The Geology of a Typical Mining Camp in New Mexico. American Geologist, Vol. XIX, No. 4.

the central peaks, forming a monocline with a dip of about forty-five degrees in a direction twenty or thirty degrees south of west, exposing the carboniferous limestones on the western slope and the underlying metamorphic granite and quartzite on the more abrupt and irregular eastern slope. Toward the northern end the limestone has been removed by the effect of a secondary eruptive which has served to dislocate and fault the limestone series very extensively and to thrust it westward obliquely across the range at a point north of the Graphic property.

North of the Magdalena range the effect of the same orographic line of weakness or fault which made the range proper was felt at a later period and formed the axis of an extensive series of trachyte eruptives. The central portion of the range was the theatre of enormous eruptive activity during the earliest or andesite period. Two craters of this age remain, known respectively as Big and Little Baldy, the first situated at the junction of the southern with the middle third, and the second at the junction of the northern with the middle third of the length of the range. The northern crater, or Little Baldy, is still quite well preserved and the walls of the crater proper expose successive flows of andesite, andesite tuff, and aphanitic phases of the same material. From this crater a most extensive rift seems to have been formed to the northward along the western faulted margin of the stratified rocks of the range, from which fissure, as well as from the crater itself, enormous masses of basic lava flowed to the north and west. Other dykes and flows in different directions intersect the region. It may be said in a general way that, as a rule, wherever these dykes penetrate or influence the limestone series there is a tendency to segregate copper, silver and lead, while in other instances, where the contact is with acid rocks, the selveges tend to carry gold. It is rare to find gold not directly or indirectly associated with these basic eruptives.

South of Little Baldy and connecting with Big Baldy is a series of andesite dykes and bosses, a result of which the limestone has been displaced eastward into the Water Canon region

where lead, copper and silver are collected, while near the crest, in dykes of felsite penetrating the andesite, gold has accumulated in appreciable quantities. Andesite areas which are evi-evidently the offspring of Big Baldy give rise to the well-known properties now being developed in the south end of the range. These are immediately associated with the andesites at the foot of Timber Peak, a lofty mountain east of Big Baldy.

On the west side of the range southward from Little Baldy, and extending to the west, north-west and south-west at a gentle inclination for many miles, is a very extensive system of acid flows which seem to have been derived from a fissure or system of fissures somewhat to the westward of the older andesite axis. These flows are of trachyte, obsidian, trachyte tuff and rhyolite. The obsidian is often black and is not infrequently found in brecciated fragments the later or rhyolite flows. Enormous erosion has operated to remove a great part of the flows and to carve the remainder into ribs and butte-like outlyers. The trachyte now seems originally to have extended northward and eastward to the very foot of the range, but this portion has been nearly entirely removed by subsequent erosion, leaving a series of low mountains or buttes at a distance of about a mile from the western foot of the range proper, while the valley in which are situated the towns of Kelly and Magdalena, as well as the Graphic and Iron Mask smelters, intervenes. Two of these isolated hills are prominent and well known landmarks, Elephant butte being the southern and Mount Magdalena the northern. These two are essentially similar in structure and form part of the great overflow which can be traced far to the south-west.

Mount Magdalena (Plate XII) owes its name to a remarkable patch of talus which is circumscribed by oak shrubs forming the perfect outline of a female head. This figure presents itself to the approaching traveler from the east and has been embalmed in the usual myths and legends. In spite of its apparently trivial nature, it seems to have remained practically unchanged for over 300 years, in fact, from the time of the arrival of the Spaniards, whose devout imaginations saw in its

pathetic expression the indelible impress of the contrition of the Magdaline. Indian superstition found it impossible to pursue even the implacable duty of vengence under the placid eyes of the lady Magdalena and the spot became a place of refuge.

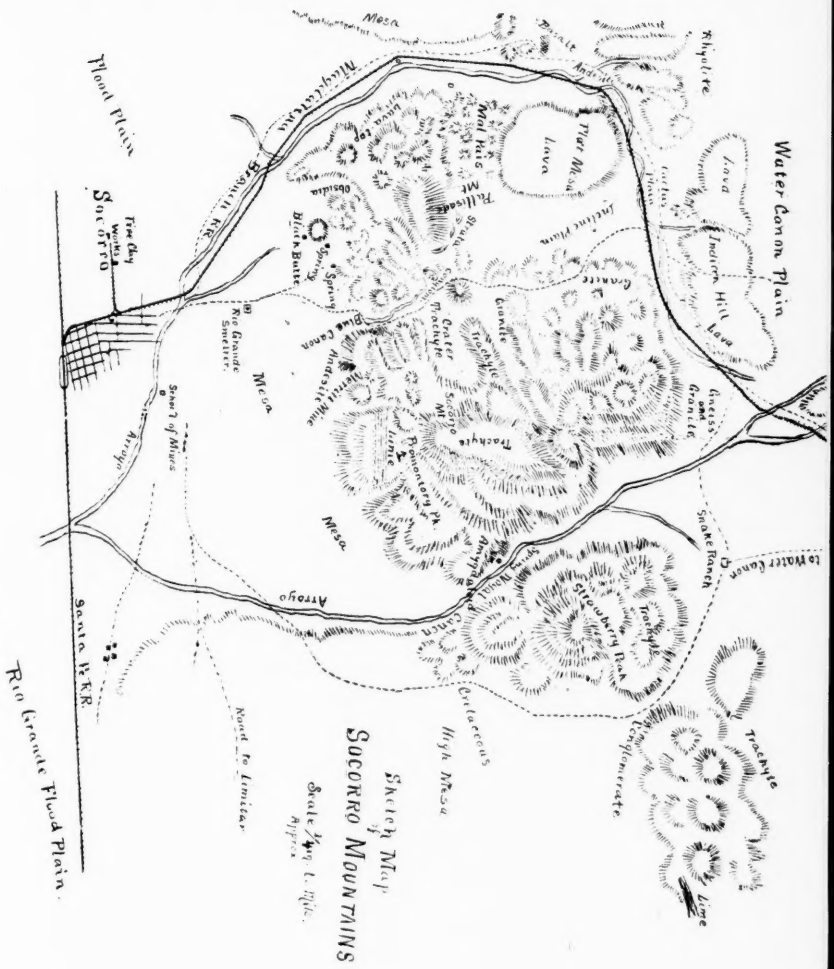
A special interest therefore attaches to this mountain, whose eastern slope rises abruptly from the valley, though the integrity of the escarpment is injured by a considerable frozen cascade of trachytic lava that curls over the brow of the mountain. It may be that some part of the mountain was the theatre of volcanic activity during the trachitic period but no adequate evidence is at hand to support that view. The base of the mountain is composed of brown and gray andesite to the hight of about 350 feet above the valley. Presumably this is a part of the great flow dating from the time of the eruption of Little Baldy and the extrusion of the great sheet of andesite and other basic eruptives in the region. The same rock crops elsewhere in the valley and we may ascribe the greater hight to which it rises here to the protection offered by the capping of later lavas which the ages of erosion have not sufficed wholly to remove. The andesite is not freely visible, being generally covered by the talus, thus it happens that its possible metallic resources have not been exploited, though the inevitable prospector has recognized the rock as similar to ore-bearing rocks elsewhere and burrowed into the veiny portions at various places about the mountain. The first deposit above the andesite was evidently of an explosive nature and was probable at or near the beginning of the acid period. It consists of banded trachyte tuff containing fragments of the subjacent andesite and also irregular pieces of dark obsidian like that which follows. Some of the pebbles are rounded and it may be suggested that the beds have been deposited during a period of intermittent aqueous flows and explosive eruption. The average thickness of this flow may be about 200 feet. Next above this, and forming evidence of a more placid type of eruptive activity is a bed of impure black obsidian. The lower layer of the obsidian contains fragments from the tuff, while the upper

merge into the trachyte. The obsidian is in some cases porphyritic with crystals which have so far decomposed as to baffle identification but are probably sanadin. Similar beds are seen at various points further west. Above the obsidian is an extensive flow of trachyte in which in some places flowage phenomena bear record of its motility while in others it seems to have crystalized quietly in situ. Quartz trachyte passing into rhyolite is apparently found near the top of the series here as elsewhere. The presence of the explosive type of lava might be taken as evidence that the mountain was itself the theatre of eruption yet such flows often extend many miles and we have found a curious obsidian breccia in a trachyitic or rhyolitic magma at Texas Spring at the distance of at least six miles from a possible source.

Magdalena mountain stands, therefore, as a natural dissection giving a vivid conception of the earlier geological conditions of the region. Passing now to the region immediately north of the main range, we encounter a series of trachytic eruptives of which "Nipple Mountain" is the first and others continue the series to the extensive trachyte crater of Bear Mountain. To the east of this range the Carboniferous limestone lies in the floor of the plain instead of being tilted as in the Magdalena range. Small quantities of lead are found in the veiny and faulted limestone and dykes of "felsite" apparently of the trachyte age passing westward into the great andesite region north of the town of Magdalena seem to have filched the lead to fill in these east and west veins. This andesite area or region of basic eruptives is interesting as probably forming a part of the product of the first Magdalena eruption and probably contains more than seventy-five square miles and may be much more extensive. It includes the Cat Mountain Camp and extends northward perhaps ten miles, while to the south, as already seen, it is for the most part covered by the later acid eruptives. The area is circumscribed to the east and north by the trachytes of the Bear Mountain series and on the west by the southward extension of the Gallinas to the Tres Montosos. At many places trachyte and rhyolite patches remain in situ above the

andesite and dykes of felsite and trachytic material cut the rock in a north and south direction, These dykes very commonly carry small quantities of gold and though most of the mines opened have been in very low grade ore the possibility is not excluded that valuable accumulations may occur. It has already been mentioned that in the same area the east and west veins seem to carry lead and the theory is offered that this is due to the fact that dykes in this direction may be in communication with the limestone region to the eastward. The lead is chiefly in the form of galena but, in several cases, a variety of vanadium compounds occur, especially in proximity to the north and south dykes. Several gold properties have been quite entensively worked but none of them in a way to really explore the dykes to an adequate depth.

The whole area north of Magdalena to the Bear Mountain is of the same general character, while the latter seems to be the product of an enormous trachyte crater from which vast sheets have flowed in all directions covering a large area south of the Rio Salado. North of the latter is the margin of the great Cretaceous region of the Mount Taylor district which has been insufficiently explored along the southern margin.



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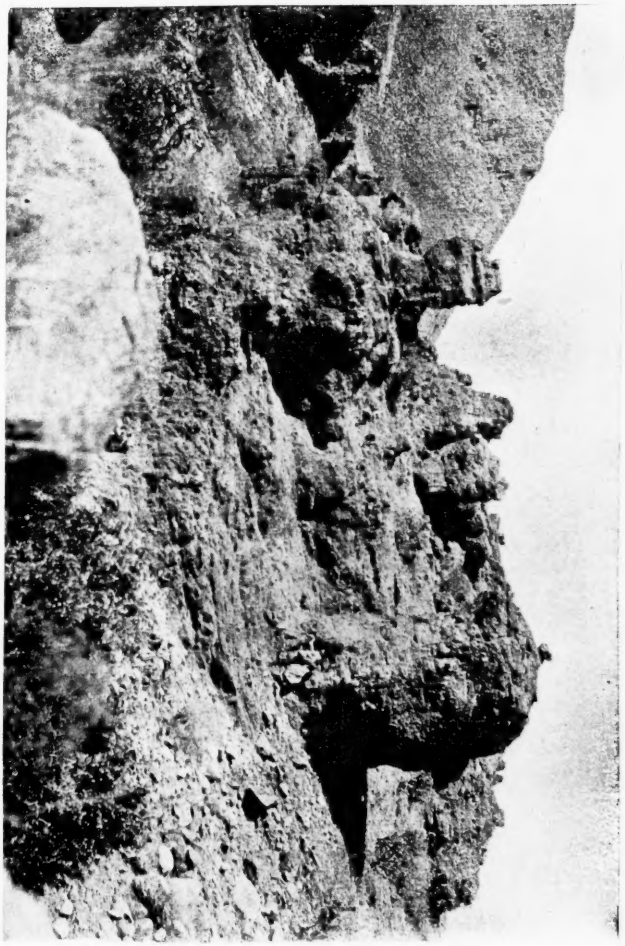

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CASTELLATED PEAKS SOUTH OF BLUE CANON ROAD.

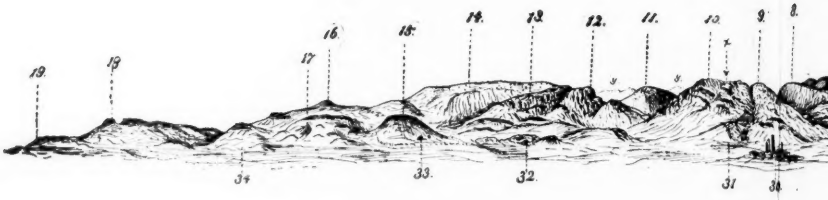

Fig. 3.

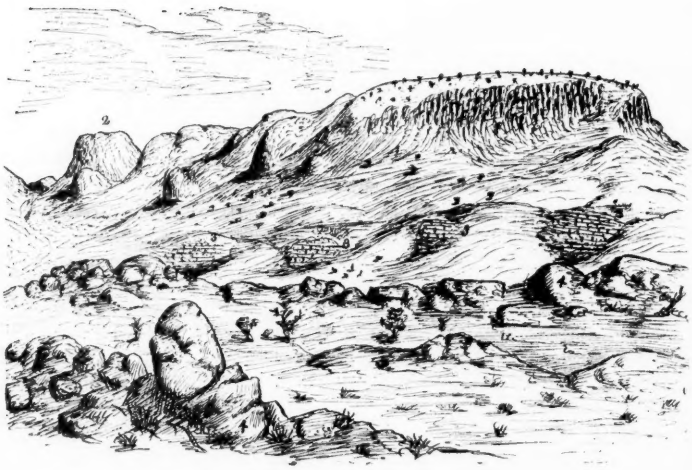

Fig. 1.

Fig. 1. Pallisade mountain from the northwest showing recent strata at 3. The foreground (4) is a granite hill over which the Blue Canon road passes.

Fig. 2. 1. Talus conglomerate. 2. Basic eruptive. 3. Magdalena Mountains in distance.

Fig. 3. Panoramic view of the Socorro Mountains from the east, from a series of photographs, as seen from the city of Socorro. The numbers are placed with reference to sources of the rocks examined and will be referred to in the section on petrography. 1. Strawberry Peak; 2. Socorro Peak, between this and 1, Nogal Canon; 3. Promontory Peak; 4. Sharp Peak, north of which a dyke cuts off the limestone seen at 22; 5. Similar small peak near which gold discovery has been made; 6. Western granitic part of main range; 7. The upper and western of two flows of quartz trachyte flowing over andesite at 27; 8. Western wall of the old crater about one mile west of 7; 9. Hill forming southern wall of Blue Canon, the lower part of andesite, upper of trachyte and rhyo-

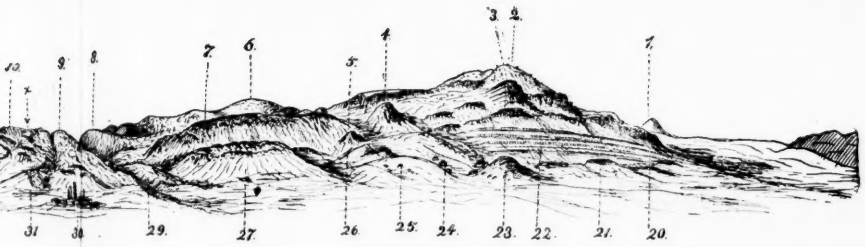

Fig. 3.

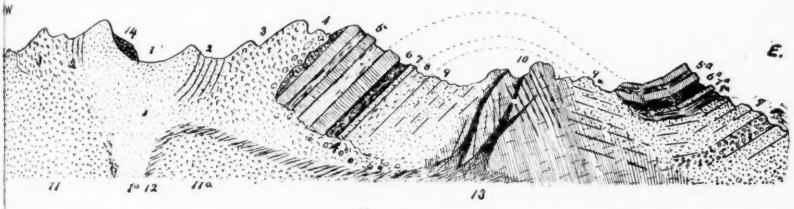

Fig. 5.

Fig. 2.

lite; 10 to 13. Various trachyte, rhyolite and breccia flows; 14. Pallisade Mountain; 15 to 19. Hills of stratified gravel and sand covered with a thin flow of recent basalt; 20. Flow of trachytic rock over the limestone; 21. Quartzite at base of limestone; 22. Carboniferous limestone, about 400 feet thick; 24 to 26. Andesite beneath, Merritt and other mines; 27. Beds of kaolin from decomposition of andesite and trachyte; 29. Blue Canon; 30. Rio Grand smelter; 31. Spring; 32. Spring and mill; 33. Ranch; 34. Clay.

Fig. 5. Ideal Section through the axis of uplift south of Limitar mountain. 1. Trachyte crater; 2. Laminated margin of trachyte; 3. Porphyry about the margins; 4. Brecciated contact zone; 5. Massive limestone; 6. Shale with Productus cora; 7 Quartzite (20 feet); 8 Shaly limestone with Spirifer camerata; 9. Quartzite passing into the next; 10 Mica and hornblende schist with quartzite bands and phases: 11. Granite; 13. Diorite, intrusive (paramorphic); 14 Talus conglomerate in or near the crater.

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MAGDALENA MOUNTAIN.

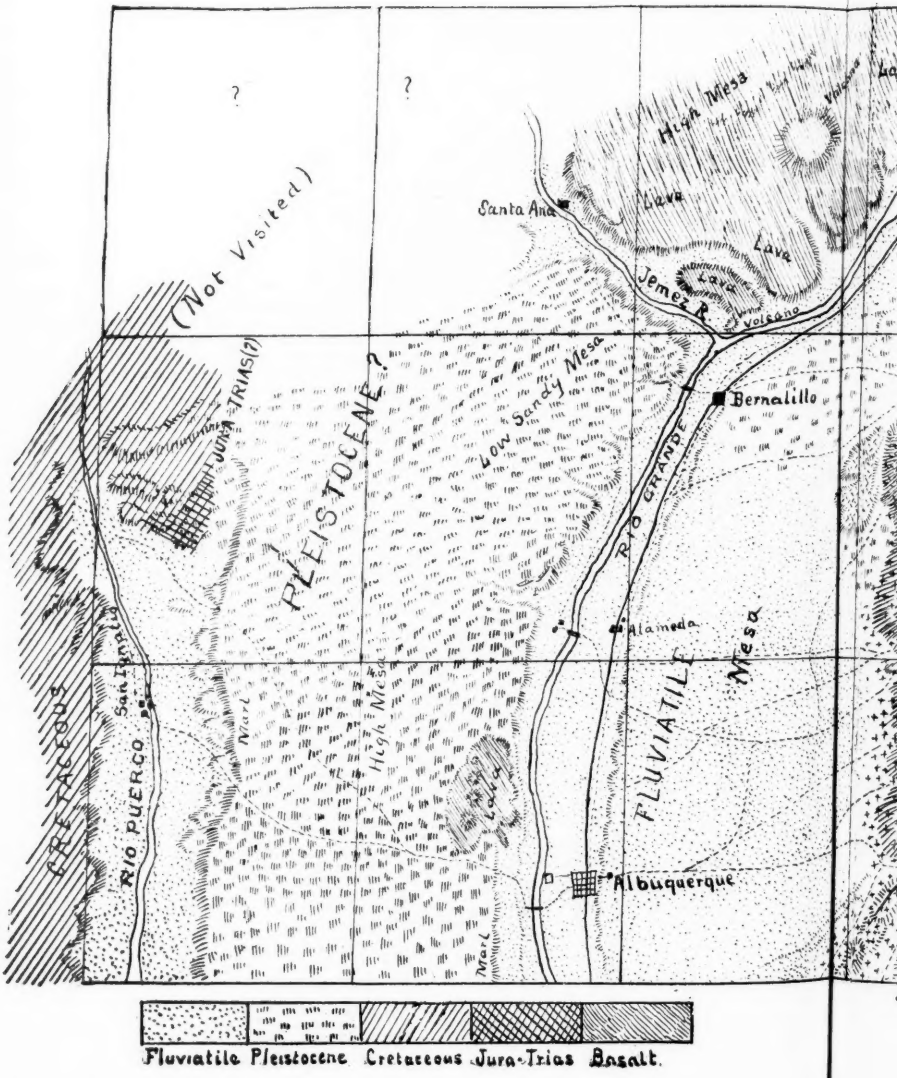

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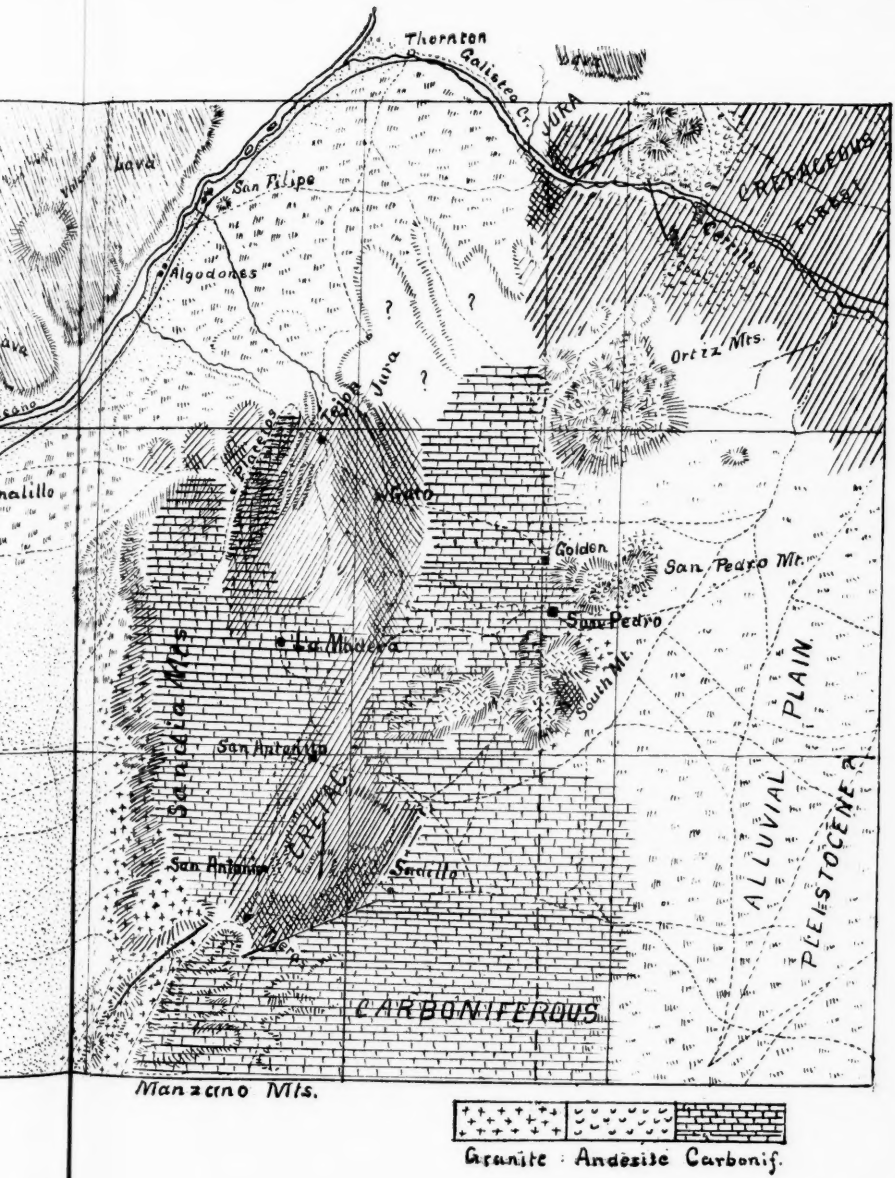
PLATE XIII.


Thornton
Galisteo Cr.
Lava
JURA
CRETACEOUS
Forest
San Filipe
Algodones
Ortiz Mts.
Golden
San Pedro Mt.
San Pedro
La Minderá
South Mt.
Sandia Mts.
San Antonito
San Antonio
Sedillo
CRETACEOUS
ALLUVIAL PLAIN
PLEISTOCENE
CARBONIFEROUS
Manzano Mts.
Granite
Andesite
Carbonif.

BULLETIN OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY.
Vol. XI. Article V, with a sketch Map. Plate XIII. December, 1898.

*THE GEOLOGY OF THE SAN PEDRO AND THE ALBUQUERQUE DISTRICTS.

By C. L. HERRICK,
President of the University of New Mexico.

The following pages are the results of a reconnaisance of the area covered by the so-called San Pedro sheet of topography issued by the government and a corresponding area lying west of that district. The country was visited by wagon and no instrumental work was done, distances being read by odometer and elevations by barometer. While a large part of the area has been personally visited and a great deal more material has been collected than can be made available at this time, it seems best to issue these notes as a guide to further work. It is to be expected and hoped that fuller details will be gathered and that the conclusions here reached may be modified by more extended comparison with adjacent parts of the territory. No attempt is made to touch upon the mineral resources, as this subject may be made the basis for a distinct paper. The paleontology and petrography are well under way but it was not thought wise to anticipate the fuller description of the final paper. Much of the area here described would be called a desert in eastern America while other portions are well-wooded and provided with flowing streams. In general, all but the lava beds is capable of supporting cattle and sheep. The southeastern portion is still well timbered. The means not being available to engrave a geological map the accompanying sketch is provided as a guide to the reader. For other contributions to the geology of New Mexico and the particular region under discussion compare a series of articles in the American Geologist, Sept., 1898, April, 1897, and July and Oct., 1898.

*Read before the Denison Scientific Association, December 10, 1898.

I.

THE AREA WEST OF THE RIO GRANDE.

The triangular area between the Rio Puerco and the Rio Grande is occupied by a nearly level mesa between 700 and 900 feet higher than the river at Albuquerque. This field is nearly level but inclines to the southeast with the inclination of the strata composing it. The dip is apparently not more than ten feet to the mile. The mesa is about three and three-quarters miles wide at a point opposite Albuquerque and increases toward the north as the two rivers diverge. Nearly west of Albuquerque is the group of recent volcanoes previouly described.[1] The cones lie on the eastern margin and consist of a group of three major and as many smaller outlets. The three larger craters rise to about three hundred feet above the mesa or one thousand feet above the river. The material is a dark basalt which was emitted in small amounts intermittantly. The upper surface is vesicular and exhibits the usual appearance of a thin sheet which has cooled rapidly. It extends to but a short distance on the west over the level mesa but extended much further eastward, spreading over the somewhat lower levels in a sheet not generally more than 20 feet thick. It formed a lobed and irregular area which has been little eroded since its outflow. The materials underlying are, so far as can be seen, the same as those forming the mesa and not those of the river valley, though it appears that there was some erosion before the eruption, perhaps by a flow of hot water as in other cases in this neighborhood. This group of cones is only one of a series of basaltic post-tertiary volcanoes which can be traced along the entire length of the Rio Grande in New Mexico.

Professor R. T. Hill has described the later volcano flows of New Mexico in general terms in the Bulletin of the Geol. Soc. of America, III, p. 98. In concluding this paper he says: "It is also evident that eruptive activity has occurred in the Texas-New Mexican region from Cretaceous to the present

[1] Geology of the Environs of Albuquerque, American Geologist, July, 1898.

time, and at least three well-defined epochs are at present recognizable which may serve as guides to future observations, viz:

1. The Austin-Del Rio system, or Schumard knobs; ancient volcanic necks or laccolites bordering the Rio Grande embayment, begun in later Cretaceous time, the lava sheets of which have been obliterated by erosion.

2. The lava flows of the Raton system, which are fissure eruptions of Tertiary time, and which are only partly removed by erosion.

3. The cinder cones and lava flows of the Capulin system, which are late pleistocene and which still maintain their original slope and extent."

The geological structure of the plateau is not a little perplexing. The upper part of all the exposures seen for a thickness of over 50 feet is composed of a finely stratified sandstone and pebble series. In places this is indurated or cemented to form a crag, while in others it is quite loose and friable. The color at a distance is grey in evident contrast to the brown or red of the lower 50 to 75 feet exposed. The latter is a mass of finely stratified clay and fine sand without the pebbly layers. At the summit of the exposure is a band of marl varying from 10 to 25 feet thick with beds of charcoal carrying plant remains. This seems in every respect to be similar to the marl previously described as forming the upper layer in the river valley, though there is a difference of over 400 feet in altitude. It might be supposed that the lower marl was derived from the older or that both had a common origin. This marl is well seen on the western exposure of the mesa facing the Rio Puerco where it extends to a point far to the north of the position of the craters of the eastern slope. It is also seen on the face presented to the Rio Grande a short distance below the craters and data are wanting to determine whether it underlies the flow. It is not found underlying the flows from the craters in the same relative position to the mesa northwest of Bernalillo, nor does it appear under the lava sheets which form the wall of the canon next north of this mesa near the town of Santa Ana. The exposures last mentioned apparently are of the same age as those

opposite Albuquerque yet there has evidently been an extensive erosion of the area separating them for the sandy layers below the lava are in places exposed for 450 feet. They consist of grey and red sands with only occasional indurated bands and are covered with sheets of vast extent but usually not more than twenty five feet thick. The thicker portions evidently were nearer the volcanic centre as the sand and clay below has been burnt and indurated and has a bright red color.

The prevailing color is reddish, especially in the lower parts. An exposure in the mesa now in question to the west of Los Corrales and perhaps five miles north of the Albuquerque flow has the same red color but is here capped by the marl which is not encountered beneath the sheets north of Bernalillo. The entire region north of Bernalillo extending west to beyond Santa Ana and extending east and north along the west bank of the Rio Grande to beyond the Indian village of San Filipe is occupied by this formation and is covered by vast sheets of basalt from craters lying to the northwest. One of these has been dissected for examination by erosion and was described as the Bernalillo volcano in a previous paper.[1]

Careful search has so far disclosed no organic remains beneath any of these flows though many miles are exposed to view. The sheets are at various levels and suggest the probability of successive superincumbent layers but, so far, there seems to be no evidence of more than one general period of eruption, for most of the flows at different levels can either be traced to different craters or are connected with other parts of the sheet by declivities or separated from them by displacements of later age. A great deal of base-level undermining is going on and even the small streams at once wear down to the general lower level. There are a few sand dunes upon the western margin of the mesa and it is likely that the major part of the local accumulations here and there found on top of the marl is of the same origin. The mesa proper is bare of trees but supports good grass as the marl is a water-bearer. To the north as the valley

[1] Amer. Geologist, July, 1898.

of the Jemes arroya is approached and the marl has been removed by extensive erosion, the surface is rolling and the sandy soil supports little beside a scanty growth of juniper. The weathering and erosion of the sandy layers leaves a very characteristic debris of dark flint and jasper as well as fragments of pertified wood.

The valley of the Rio Puerco, about three miles wide at a point west of Albuquerque, is about 725 feet deep and its upper course is carved out of Cretaceous sandstone and shales. On the west side these strata reach the present river bed at the so-called Punta de la Mesa two miles north of the little town of San Ignacia which is north-west of Albuquerque. The river here seems to occupy the site of an anticline, the strata to the southwest, the exposures of which diverge from the river, dip to the southwest by a very small angle, while those on the opposite bank dip to the southeast. In fact, this line of flexure crosses the strata a few rods from the river, which doubles round the point. The most complete exposure at this place is about 325 feet high, the lower 250 feet or so being of dark fissile shales with sandy layers and concretionary and gypsiferous phases. The upper 75 feet or less is of a variable reddish or yellowish sandstone with local white sand deposits. The continuity of the series is much broken by minor faults so that neither the position or dip of the strata is constant over large areas and the lithological characters are also quite inconstant. The upper nodulary phases of the sandstone in some places are quite fossiliferous. Only a short distance below the bottom of the sandstone layers is a more or less constant band of carbonaceous shale which in some places becomes a lignite. Still below this is a zone in which occur large numbers of calcareous concretions. Each of these when broken reveals the presence of a fossil, generally one of the two fine Goniatites figured later, while a few small fossils occur in the shales. To the north of the point the escarpments of the rocks described continue to flank the immediate valley of the river for many miles. On the east side the same series is repeated by faulting and reappears to the east in successive ridges. In these exposures it often happens

that the yellow and irregular banded sandstone is substituted for by massive white sand for shorter or longer distances. Above this layer is a conformable bed of yellowish loamy clay which is very finely banded and homogeneous. To the east the inclination of the faulted blocks becomes less, those near the river having a dip of about five degrees. Near the eastern margin of the valley the strata are nearly horizontal and the Cretaceous strata describe above disappear below the surface. Their place is occupied with bands of sand which have the texture of the upper loamy layer mentioned as overlying the Cretaceous near the river. The color is variable however and the strata are so disturbed that it cannot be said certainly that the two are part of the same system. We incline to that view and think that the red sands which appear in the eastern wall of the valley, inclined at a barely perceptible dip, are of the same age as the outliers in the eastern part of the valley and these in turn of the same age as the remnants of fine material on the upper surface of the Cretaceous near the river.

At present we can only conjecture that these sandy beds are of Tertiary or Pleistocene age.

2.

THE SANDIA MOUNTAINS.

This range is the most conspicuous mountain group visible from Albuquerque, directly east of which it lies at a distance of from five to eight miles. The highest point of the range is about 10,000 feet above the sea or a little more than 5,000 feet above Albuquerque. The mountains are part of a great monocline which extends along the left bank of the Rio Grande to the south. This monocline passes into an anticline by degrees, as the Ladrones, Limitar Mt. and Socorro range contain the same formations dipping to the west on the right bank. The Rio Grande may be said to occupy the axis of an anticline or, better still, an axis of disturbance which in various parts has resulted in different geologic structures according to circumstances. These disturbances were inaugurated, so far as the

geological record shows, in pretertiary time by the series of andesite eruptions and have continued through a trachytic and rhyolitic period and in post-tertiary time have been supplemented by the basaltic flows now so prominent in the topography of parts of this district. The Sandia range is separated from the continuation of the uplift to the south by Tijeras canon, itself marking, as we shall see, a transverse axis of disturbance. The length of the range is about 20 miles but the deflection of the valley of the Rio Grand to the eastward in the northern part of our sheet causes the western escarpmeut to bear off in that direction and, this being in the direction of dip the height falls off rapidly in this part toward the north. The crest of the range is everywhere a band of Carboniferous limestone 400 to 600 feet thick. The maximum thickness is not preserved, so that the upper horizons of this formation are better seen in the nearly horizontal beds to the east.

The dip being from eight to twelve degrees to the southeast those peaks lying most to the westward are, of course, highest. The age of the limestone is abundantly attested by the fossils, while below them is a vast series of metamorphics the age of which it is impossible to more than conjecture. These metamorphics are of two groups which are distinguished by their lithological character and conditions of formation though they may be practically contemporaneous. In general, the limestone is underlaid by a mass of quartzite of varying thickness. This, where the metamorphism has been slight, is obviously of a sedimentary nature having conglomeritic phases. In other places this quartzite has been perfectly transformed into a granite or gneiss. It thus happens that in many places the limestone reposes on a crystalline granitic rock. In other places the granite is more than fifty feet below the base of the limestone. The second series of metamorphics is found at certain foci of uplift. One such focus is seen in the foot hills to the west of Sandia peak, the high mountain at the north end of the ridge, another just at the mouth of Coyote Canon at the east end of the transverse axis of uplift which forms Tijeras Canon. Another and more important one occurs further south

in a similar relative position at the mouth of Canon Largo and forms the geological cause of the Hell canon mining district. These foci of uplift and metamorphism are evidently metamorphic centres also. Taking, first of all that which occurs south of the mouth of Coyote canon, we find here that there is a boss-like area of quartzite around which the remnants of the limestone have clung and these dip in all directions away from the centre. To be perfectly accurate we should say rather that these points have not settled as much as the adjacent parts for here, as elsewhere under the like conditions, the area of greatest plasticity has been a little away from the line of greatest elevation. In this same area too there is the evidence of special secondary metamorphism as there are masses of schist of the most various kinds as well as paragenetic diorite.

The larger focus west of Sandia peak is of essentially similar character though there are no remnants of the superposed lime. The rock has become a schist of various species and is intersected in various directions by large dykes of quartz. The most highly metamorphic phase is diorite and the circumstances are such as strongly to reinforce the theory long since propounded by the writer on the evidence of Lake Superior lithology that the diorites are paragenetic and not independent igneus intrusives. No core of basic eruptive is exposed, though it may exist. It is probable that these metamorphic areas are old and that they may under favorable conditions produce some mineral. The third of these foci in the Hell canon district has been quite carefully studied and the results are given elsewhere. Here the metamorphism has produced large dykes of quartz and diorite, the former carrying some free gold. A little depth however soon converts such metal into sulphides and the present prospect is that sufficiently deep mining may yield some copper in the form of glance and pyrites.

The western slope of the Sandias being quite abrupt, the face is cut by short canons in the granite with deep dells and recesses in which there grow, especially near the summit, a number of plants evidently strays from the far north. The eastern slope, on the other hand, being quite gradual permits

the mesa flora to rise to near the summit. A deep canon in the north end known as Placitos canon serves to collect the water from the northern part of the range and forms a most fruitful valley.

The Tijeras canon on the south cuts the range abruptly off and the whole area from this canon to a point some miles south of Canon Largo, a distance of at least ten miles, has dropped out of conformity with the portion of the range both to the north and to the south.

The cause of the fracture in the case of Tijeras canon is not far to seek but consists in a massive upthrust of a quartzose rock which passes obliquely across the range from southwest to northeast, terminating at the western end in the neighborhood of Coyote springs and at the eastern extremity in the vicinity of Whitcomb's springs. It is a curious fact that the opposite ends should give rise to nearly the same conditions, the springs in both cases being highly mineralized. At Coyote especially the springs are highiy carbonated.

The following is the result of the analysis of a sample of Whitcomb spring water by Prof. Randolph W. Tinsley, of the University of Mexico:

Sodium Chloride, grains per gallon	.1927
Calcium Sulphate, grains per gallon	1.4360
Calcicum Carbonate, grains per gallon	8.1896
Magnesium Carbonate, grains per gallon	1.5188
Total	11.3371

The width of this axial dyke varies from 25 to over 50 feet, and it is flanked by metamorphic rocks like hornblende and mica schists and diorite. Near the eastern end of the canon the schist and diorite come into close proximity to the limestone and the latter is greatly faulted and dislocated. At the east end of the canon the strata of the Jura-triassic and Cretaceous abutt upon the Carboniferous, so that the town of Tijeras is on the Jura-triassic area.

3.

THE AREA NORTH OF THE SANDIA MOUNTAINS.

From the northern portion of the Sandia range there is a strong spur or isolated uplift composed of granite and schists intersected with dykes of diorite and of quartz. This spur projects westward toward the river and gives rise to springs and streams of beautiful water. This area has not been sufficiently studied but is evidently the focus of iocal metamorphism as described above. To the south of the spur a small portion of the same formation as that which underlies the lava beds to the north and west of the Rio Grande protrude through the river gravels and consists of the same red detrital materials. Near the river in the neighborhood of Alameda is a deposit of pumice evidently from one of the craters in the neighborhood of Bernalillo. To the north of this place the supposed pleistocene crops in the river bed as it does at several places even further south. It also appears in the hills and seems to be greatly commingled with the river gravels. North of the Sandias to the river and Galisteo creek and eastward to the Jura-triassic area east of Thornton the surface is irregular and is worn by erosion into deep gullies. The material is chiefly unindurated sand and crag with shaly layers. This may, in all probability, be referred also to the Pleistocene. In fact, evidence that this is the case is found in the neighborhood of the little Indian town of San Fillipe where an outlyer of the lava on the east side of the river forms a small isolated mesa about 100 feet above the general level. The river gravels are seen on the eastern aspect rising half way to the top and enabling one to observe the contrast. It would appear that the exposed soft materials have eroded faster than the same strata on the west side of the river where protected by the lava as is also the case in the area opposite Bernalillo on the west side of the river and south of the lava. This eroded country is denominated "the bad lands," but has no relation to the *mal pais* resulting from the breaking down of the lava flows met in many parts of the territory. Going east, the country rises to about 525 feet above.

the river. Here is a bed of marl and crag reminding of the superficial layer opposite Albuquerque. The whole area south of Thornton seems to be similar till the Jura-triassic area at Galisteo creek west of Cerrillos is reached. At the very north end of the mountains the foot hills seem to be of Cretaceous and Jura-triassic but the disturbances have been so great that little has been done in unravelling the complicated relations. A deep canon cuts far into the range from the north, at the mouth of which is the Mexican town of Placitos. The canon is due to the extensive fault in the Carboniferous limestone by which the lime after dipping from the crest to near the general level on the west side of the canon, reappears on the east side in a precipitous cliff of perhaps 600 feet. The valley is cultivated for a number of miles and apparently contains Cretaceous strata. At the extreme northern limit of the eastern wall of the canon there is a series of springs and a very confused area. It here appears as though the limestones of the Carboniferous were followed with only slight disturbance by the beds of the following formation. A limestone occurs which contains fragments of Carboniferous lime together with their fossils commingled with fossils of a different habitus. The remains are poorly preserved and no decision can now be reached as to their age. Among these beds are others composed of red granite fragments, forming a small-grained conglomerate. Red sandstone and shales seem to follow, to be in turn succeeded by banded quartzite and other beds of shale and sand and still other strata of quartzite. The strata all dip to the east and it is hard to determine whether the series (here regarded, on lithological evidence alone, as Jura-triassic) is quite thick or whether it is frequently repeated by faulting. East of these exposures there is a very prominent ridge with its abrupt escarpment toward the west offering the following section: at the base at least 200 feet of red sandstone with irregular layers of vesicular limestone, then 85 feet of saccharoidal white sandstone and on top a band of 15 to 20 feet of yellow limestone. This section is crossed by the road to Tijon where are saline springs. It is probable that the upper part of the section is Cretaceous. The region to the east of this ridge

is probably Jura-triassic. Passing south, there are low hills with gypsiferous shales and gray and white sandstones nearly to La Madera which seems to be upon a plateau of limestone, broken in places by granite or other igneous rocks. From San Antonio to San Antonio is a Cretaceous region and along the roadside we find about 50 feet of shales with lenticular masses of limestone topped by an eqal amount of freestone. Between San Antonio and Tijeras the boundary between the Cretaceous and the Jura-triassic is crossed through here the disturbed stratigraphy is difficult to unravel. The valley of the creek from "Uno de Gato" to Alamillo and southward is occupied by the red Jura-triassic. Ascending the creek we encounter horizontally stratified beds of clay possibly of Pleistocene age reposing on older tilted rocks.

4.

CARBONIFEROUS AREA SOUTH OF TIJERAS.

On the east side of the range, south of the town of Tijeras is a region consisting chiefly of rough and rolling country quite densely timbered. Passing south of Tijeras, which is situated on the Jura-trias area, about half a mile, the contact between the Jurassic red sandstone and the Carboniferous limestone is clearly seen. The contact is along a sharp fault extending approximately east and west—a line which may be followed at intervals for many miles. The upturned edge and adjacent parts of the lime are metamorphosed and filled with segregated silica. The dip is to the southwest in the immediate vicinity of the fault while the Jura-triassic on the opposite side dips northeast. To the south of this fault the country is wholly made up of Carboniferous strata. The series is nearly horizontal with slight variation in different directions from the horizontal plane.

Although there seems to be no place where the entire Carboniferous series is exposed from bottom to top the following section is no doubt nearly complete and embraces over 600 feet commencing with dark fossiliferous limestones such as are elsewhere found near the base of the series. The fossils are such

as Productus cora, Spirifer opima, Martinia concentrica, etc. The section is about as follows:

First, 225 feet of dark, bedded limestone, followed by 50 feet of shales, then 150 feet of gray massive limestone on which reposes about 25 feet of reddish or yellowish sand-stone. Then follows 100 feet of limestone with a thin bed of shale and a few feet more of lime making up an additional twenty feet. Then follows 25 feet of sand-stone and 25 feet of lime to the top of the exposure. Carboniferous fossils may be found to near the top though it is possible the very upper portions may contain representatives of a Permean fauna. It will be noted that this section contains sand-stone members near the top not seen in sections apparently as complete further east. It is probable that the present section actually reaches higher levels than the latter and that a certain part of the limestone series is below the present section and is to be added to the total thickness.

Passing eastward the strata become practically horizontal and the country more level. The fault line between the Carboniferous and the Jura-triassic is well seen at the little town of De Vaca about two and a half miles east of Tijeras. The limestone and the sands of the Triassic both dip to the northwest but in no place were the two seen in conformity. At this place it is the upper part of the Carboniferous that emerges and it is here filled with bryozoa and a narrow horizon is distinguished by being almost made up of small foraminifera of the genus *Fusulina*.

The Carboniferous extends eastward and apparently covers the entire rolling country to the valley occupying the eastern part of the sheet. At Sedillo it is well exposed and is still nearly horizontal. Further northeast it seems to be uplifted so that the underlying quartzites are exposed two miles northeast of Sedillo. This area is covered with a sparse growth of cedar and pinon and seems to be available farm land where ever irrigation is possible.

An irregular line extending north and south along the eastern third of the sheet is the axis of uplift occupied by the mountains of the San Pedro group, which are, beginning at the

south, first, South Mountain with its westward extension of granite hills, which we may call the San Antonito mountains. Next north is the San Pedro peak with its foot hills. Then the Ortiz group and, finally, north of the Galisteo creek, the Cerrillos range. In all these, except the San Pedro mountain, the greater part of the uplift seems to be of granite of the metamorphic series. The Carboniferous limestone skirts the southern border of South Mountain and extends nearly to San Antonito and encloses the area of Cretaceous and Jura Trias extending from Tijeras to the latter place. Directly west of South mountain there is preserved a bold escarpment of the Carboniferous. Here the granite is exposed from time to time below the Carboniferous but the lower 175 to 185 feet is partly covered and partly obscured by an interpolated intrusive. (A section of this rock shows it to be an orthoclase porphyry with hornblende and diallage?) The upper part of this portion seems to be an earthly limestone. This is followed by ten feet of fine shale such is commonly found within a hundred feet of the quartzite, and this is followed by a fossiliferous shale with the characteristic faces of the lower member of the series. Productus *Spirifer opima* and *Martinia* are abundant. Seventy-five feet of dark bedded lime follow, after which the lime has a vescicular character with nodules of chert for one hundred and ten feet. The next 120 feet is more homogeneous and of a gray color and has a large species of Athyris as the characteristic fossil. The upper twenty feet of this member inclines to be shaly with a yellow color and is filled with bryozoa. At this level too is a belt of Fusulina limestone. The remaining forty-five feet is made up of massive dark gray lime with bryozoa. It is evident that this section lacks the upper portion and the sandy beds noticed in sections further south and west are here absent.

From this exposure to a point west of the Ortiz mountains the limestone is the country rock, though it nowhere rises to so high a level as here. It apparently extends uninterruptedly between South Mountain and San Pedro Mountain and not far east of the town of San Pedro it is sufficiently charged with

lead to give rise to productive mines. The ore concentration may be ascribed to the influence of the San Pedro crater and affords a beautiful illustration of the relation of metamorphism from local vulcanism to ore assemblage. On the west the limits of the Carboniferous are marked by an abrupt or even precipitous drop to the area of the valley occupied by a stream flowing north into the Rio Grande north of Bernalillo. Here the red sands and shales ascribed to the Jura-triassic lie in confused dip, the fragments being faulted in various senses. The Carboniferous again appears in irregular patches on the west side of the stream nearly horizontal in position and obviously forming fragments once continuous with the Sandia block. The whole area in this sheet east of the mountains and south of the Galisteo creek is an alluvial valley and seems to be underlaid by the Carboniferous and possibly some of the later strata. It is the only part of this sheet that promises to afford artesian water and should such wells prove successful this beautiful valley will become the garden of the territory.

5.

THE GEOLOGY OF SOUTH MOUNTAIN.

The clustre of peaks by the above name is at the southern end of the series of rather isolated mountains lying east of the Sandias and faces the extensive valley forming the eastern part of the sheet. From this valley it rises abruptly and the granite core soon breaks through the fringe of sedimentary strata at the base, and rises in bare crags to over 8000 feet. A lobe of the valley to the eastward passes westward immediately to the south of the mountain giving to it an isolated appearance from all directions, though to the west it extends in a series of lower hills of granite, schist and gneiss nearly to the town of San Antonito. About the eastern base there are perhaps a hundred feet of red sandstone which probably is of Jura-triassic age. These strata dip away from the main peak at a slight angle. To the west it is the Carboniferous limestone that skirts the base. These limestone strata extend far up the western foot hills and are much titled and faulted. The north and south val-

ley or canon which separates the main range from the western foot-hills exposes a vast series of schists of great lithological variety. Occasional diorites exhibit the extreme of metamorphism but no true intrusives were seen. All portions of the range were not visited and it is possible that some intrusive outbreak was overlooked but in that case it must have been quite insignificant.

6.

THE SAN ANTONIO AREA.

The area east of San Antonio and thence to De Vaca is peculiar and in some respects unique. At De Vaca is a fault extending northeast which is in all probability the extension of the similar fault seen a short distance east of the town of Tijeras. The carboniferous lime is here abruptly cut off and the Jura-trias appears on the west side with a strong dip to the northwest. These strata appear in two ranges of hills to the northwest, beyond which the Cretaceous appears either following in normal sequence or, as is more probable, on the down side of another fault. The country in this neighborhood is very rough, the lower parts of the exposures revealing a dark carboniferous shale, at which horizon coal is occasionally mined, as is the case north of the cabins of Gutierez. The upper members are of a yellowish freestone capped with a more dense white sandstone. An irregular but rather continuous escarpment forms a bluff which is a conspicuous landmark from a distance whence the land ultimately slopes to the region about San Antonito, the interval being filled in with Cretaceous. The dip is generally north and northwest but is modified by at least one north and south dyke. The one in question is of peculiar interest as being probably the last remnant of a volcano that once existed about a mile east of San Antonio. At this place is a large amphitheatre of at least a mile in diameter bounded to the north, east, and west by the escarpment of Cretaceous just mentioned, on the south in part by a low hill of Jura-trias.

This amphitheatre is now a fertile valley but from its northern arc a dyke of basic igneous rock pierces the escarpment to

the north which is affected by its forcible intrusion in such a way that it dips away from the dyke on either side. At this place the freestone is filled with impressions of a single species of mollusk. The exposure is as follows: gray, fissile, earthy shale, 75 feet, the upper part being carbonaceous and partings of flags occurring throughout; thin-bedded grey shales, 75 feet; sandy shale with flags, 50 feet; freestone with fossils, 140 feet; crystalline white sandstone, ten to twenty feet.

Between this amphitheatre and San Antonio the series seems to be twice repeated by faulting and between the later place and Tijeras there is a series of hills containing the Jura-triassic.

7.

THE CERRILLOS AND ORTIZ AREA.

About six miles west of Cerrillos on Galisteo creek a narrow zone of the red Jura-triassic shales and sandstone outcrops. The dip is here east and northeast perhaps 25 degrees. A careful search discovered no fossils. North of the creek the Cretaceous strata rise to a height of about 375 feet above the track. The section at this place is as follows: 50 feet of red shale and sand capped with hard red sandstone, then 175 feet of white sandstone of varying consistency, 75 feet of chocolate shales with concretions in bands, followed by twenty feet of sandy white shales with a band of white sandstone about three feet thick below and a somewhat thicker one above, 30 feet of sands and shales and at the top 25 feet of indurated sandstone or quartzite with conglomerate. The base of this series may be Jura-triassic. Passing eastward, after what seem to be two partial repetitions of this section by faulting, we encounter a section with quartzite at the base which passes into white sandstone, then 20 feet of bluish black shale, a zone of red calcareous concretions and 25 feet of dark fissile shale and 15 or 20 feet of yellow sandstone. After crossing a deep valley the following section is encountered; 115 feet of gray shales and thin flags with numerous Cretaceous fossils, covered with a sheet of about ten feet of what seems to be a basic eruptive rock similar to that covering a great deal of the region about Cerrillos.

This flow proves to be a characteristic lencite phonolite. From this point to the western foot of the Cerrillos mountains the same fossiliferous shales and flags occur in low hills. Essentially the same sequence occurs south of the creek. The region to the west and south of the mountains are cut by radial dykes which beautifully illustrate the way in which these dykes habitually occur. The intersected rock being in this case for the most part soft and easily eroded, the dykes are left as conspicuous walls rising several feet above the general level, and may be traced for six or eight miles continuously. They vary from two or three feet to twenty feet in width and the same dyke may vary greatly in this respect. The material, so far as can be determined without a section, may be an andesite but in the thicker portions it tends to be replaced by a felsitic material. This may be explained upon the supposition that where the local metamorphism was great the fused acid material expanded the original fissure by disintegrating the walls and, in some instances nearly or quite suppressed or obscured the eruptive.

The alteration phenomena in proximity to the dyke are quite interesting. In particular, the formation of chalcedony and jasper from the siliceous wall rock is plainly seen. The influence of the sheets of the same material, while less pronounced, is no less apparent, for the shales and limestone so covered have become flectuously lammelate and crystallized. The source of the flows as well as of the dykes is no doubt the south end of the Cerrillos mountains which are composed of a similar material. The northern part of the range is of granitic rock which may be later than the old phonolite nucleus. This region gives us the suggestion that the phonolites are probably post-cretaceous. To the northwest of the mountains, about three miles from their base, is a recent basaltic crater from which extensive flows of lava have spread to the west and southwest. Along the southern margin of this sheet there has been very extensive base-leveling erosion exposing from 50 to 75 feet of the soft strata beneath. In the vicinity of the mountain, along its western base such exposures are very instructive and give the surest clue we have so far seen to the age of the several

intrusives. Here, for example, at the base of the exposure are 60 feet of dark, horizontal, Cretaceous shales intersected by nearly vertical narrow dykes of what looks like a basalt though much decomposed. The strike of such a dyke about two feet wide near the road to Santa Fe is N. 10 degrees W. Above these shales is a bed of crag and loose material over 50 feet thick. The bowlders at the bottom of this series are of phonolite similar to that of the mountains at the south end of the range. The whole is capped by 25 feet of recent lava from the adjacent cone. The basalt dyke referred to stops short at the top of the shales showing the upper loose zone to be of later date than the intrusive. The shales, which dip to the east at a distance from the mountain, become horizontal as they near the range and, near its base, dip to the west. We may assume that the phonolite uplift, at least the later part of it, occurred after the deposition of the Cretaceous and that the later deposits (perhaps Pleistocene) result from the erosion of the resulting materials. The extensive dykes radiating from the mountains and cutting through the strata may therefore be of the same age as the main mountain uplift. Though the northern and higher peaks of the range are of granite it is probable that this uplift is parasitic upon the basic eruption.

At Waldo, about three miles west of Cerrillos, at a point about a third of a mile north of the track, is a prominent mountain of porphyritic gray eruptive which shoulders its way through the dark Cretaceous shales. From this region a strong dyke extends southward and is apparently the same that intersects the coal workings of the Cerrillos Coal Co., near the breaker, and may be the principal cause of the special metamorphism which has transformed the bitumenous coal to anthracite at this place. This dyke is about twenty feet wide and is a prominent landmark. The other hills of the Cerrillos range between Waldo and the town of Cerrillos seem to be, for the most part, composed of the same basic eruptive as is the country to the northward nearly to the foot of the granite mountains of the northern part of the group. The country for two miles or more north of the town is broken and, while the country rocks seem

to be basic, it is intersected with acid dykes that may be derived from the same source as the granite of the northern peaks. These acid dykes in a basic rock carry a small quantity of gold as is the almost universal rule under these circumstances. Extensive superficial prospecting has resulted in opening no important mines thus far. To the east the Cretaceous sandstones and shales occupy the surface for many miles and, in one locality a few miles east of Cerrillos, there is a considerable area covered with the silicified trunks of large trees—in short a buried and petified forest is exposed. The trunks are frequently only partially exhumed by erosion and protrude from the sandy matrix in a horizontal position. The Omera coal banks fourteen miles to the east and south of the railroad have at various times been extensively worked but at present the coal shipped by the Santa Fe comes entirely from the extensive mines at Madrid two or three miles south of Cerrillos. The detailed study of this interesting region is reserved for a special paper. The rocks are of Cretaceous age and consist of about 150 to 200 feet of alternating shales and sandstone. The higher layers are often of a yellow freestone not unlike the Waverly rock of Ohio in appearance.

The whole is much disturbed and faulted and seems to have been covered by a flow of basic material of varying thickness which in some place has given place to a crag of materials derived from the erosion of this sheet. Immediately above the anthracite is a thin bed of a black basalt-like intrusive that seems to have qeen injected between the strata or to have covered the roofing shales of the coal. It may be that this sheet is to be connected with the dyke above mentioned. It is a question whether the superficial sheet of phonolite (?) has had much part in the metamorphism of the coal though that seems to be the local theory. Passing to the south, the gray igneous rock assumes greater importance and occupies all the foot hills to the granitic or gneissic core of the Ortiz range. The Cretaceous bounds the mountain on the northwest and the entire western base is apparently occupied by the Carboniferous.

A deep valley separates the Ortiz from the San Pedro

mountain, the former, so far as observed, being composed almost exclusively of granite rocks, while only the northeastern part of the San Pedro mountain is granitic. The latter will afford an interesting field for study as it is essentially an old andesite crater with more or fewer parasitic acid flows. The Carboniferous lies upon its southwestern flank and has been subjected to so great metamorphism that the lead content has been segregated and considerable mines of carbonate exist in the neighborhood of the town of San Pedro. The foot hills near Golden on the northwest of the range are of Carboniferous limestone also but in the valley separating San Pedro mountain from the Ortiz group is a tongue of Cretaceous sand and shale. The crater proper occupies the entire center of the San Pedro mountain, the rim being broken at the northeast at the locality of the Saint Lazarus mine and mill.

West of the Saint Lazarus mine a section of the wall of the crater is as follows: 200 feet of sandy and calcareous material highly metamorphosed and serpentinized. This may have been an earthy limestone with sandy bands. The dip is into the crater, i. e. to the northeast. Next is 100 feet of altered limestone like the lowest horizon, then a sheet of andesite aphanite lying conformably above the sedimentary and serving highly to metamorphose it at the contact. At this contact is a certain amount of copper stain which has excited the curiosity of the prospector. The dark band is visible for miles and has universally been called the "black lime" by the miners. Above the aphanite is a variable amount of acid rock—perhaps a felsite. The south and western rim of the crater are quite sharp and are essentially similar tnough more of the andesite is found in places. In the interior the andesite is more in evidence and is mixed with acid flows giving rise to the conditions for gold collection. As a matter of fact there is gold in the placer gravel within the crater practically everywhere. The contacts of the andesite and the acid rocks are also habitually auriferous and are worked to a considerable extent, the "Gold Standard" mine being quite well known locally. The northern wall of the crater is broken by a massive dyke extending north and south

and other dykes extend in various directions into the surrounding country. To the east there have been extensive flows the sedimentary rock having been removed to a great extent and the important flows being of andesite and an acid "felsitic" material. In the vicinity of Golden there has been some extensive placer working, the results of which it is yet too early to ascertain.

The northeastern part of the territory, from a line passing through Raton and Las Vegas and thence southeast, is said by Professor R. T. Hill to have formed a part of the Tertiary continent and not to have been submerged since the Cretaceous. (Bul. Geol. Soc. Am. III, 86, *et seq.*) "The cities of Trinidad, Folsom, and Las Vegas may be considered as bench marks along the northern, eastern, and western boundaries respectively of this region, while Raton, Springer, Maxwell, and other points along the Santa Fé railroad between the Purgatoire, at Trinidad, and the Pecos are located upon it. The southern boundary is the superb escarpment of the Canadian Pecos valley."

"Everywhere is seen the grand result of profound erosion by which the overlapping formations (Dakota, Denison, and Trinity beds) have been stripped from the horizontal red beds, which constitute the valley floor, and has left standing in the valley numerous remnants of the plain in the shape of great circular buttes and mesas, such as El Corazon, The Gavilan, Mesa Rico, Mesa Redondo, the big and little Haarfando Mesa, Tucumcari, and others, every stratum of their red, brown and white beds being visible in horizontal bands for scores of miles."

"The erosion from top to bottom of the successive plains of stratification has partially removed more than 5000 feet in thickness of sedimentary strata."

8.

THE CARBONIFEROUS.

In the Rio Grande region of New Mexico the Carboniferous formation is remarkably homogeneous. It always rests

with apparent conformability on a series of quartzites that form the transition into the metamorphic granites and gneiss below and the thickness of the quartzite often seems to depend on the amount of metamorphism to which it has been subjected. In some places the limestone seems to rest diretly on the granite but these cases may be interpreted as instances of extreme metamorphism that have caused the qurtzite to assimilate to the granite. There seems to be every reason to suppose that the band of quartzite is of a different age from the granite as well as to believe that the granite itself is of sedimentary origin. The basal quartzite is usually from fifty to seventy-five feet thick while it may drop to ten or twenty feet. A few fossils have been found in the upper shaly layers but they probably belong rather to the shales which next follow. These shales are frequently highly metamorphic but are fossiliferous. The quartzite has conglomeritic phases with granitic and other pebbles. It reminds one by position and lithological character of the basal conglomerate lying under the coal measures of Ohio and Pennsylvania but no homology is suggested. The conglomerate quartzite is frequently the catch-basin for the leechings of the limestone and sand-stone above and accordingly is of some importance as a collector of intrusive ore. See account of the Caballo mountain ore in another place.

Immediately above the quartzite is usually a band of shale of about ten feet followed by perhaps 150 feet of fossiliferous limestone. It is in the shaly beds in this horizon that the most abundant fossils are to be found. Spirifer opima, Productus cora, Martinia concentrica, etc., are the characteristic species.

In typical sections this lime is followed by about twenty-five feet of conglomerate or sand-stone. There follows about three hundred feet of limestone which tends to grow lighter toward the top. This is not very abundantly supplied with fossils. It may be separated from the next member by a thin band of bandy shale. In many exposures the next fifty feet is the prominent portion of the series it being a specially massive and permanent band of limestone. The next 125 feet is fragile and contain Productus nebrascensis (?) and large Spirifers

and a large Athyris as the characteristic fossils. Four to six feet of shale may occur at this point. About 25 feet higher is a peculiar greenish layer with a sandy tendency. Still 60 feet higher is a definite sand-stone layer often characterized by the presence of much feldspar in the sand. This band is about ten feet thick and is followed by about 100 feet of gray lime.

The sandy members are not very constant. The position of the zone of bryozoa and Fusulina bed is probably near the prominent bed of lime mentioned and, as this is often the apparent top of the series, the beds are frequently quite accessible.

The nature of the transition into the Jura-triassic is still obscure. At the north end of the Sandia range is an exposure where the transition apparently can be seen. The extent of disturbance is however a drawback. So far as can be seen the base of the red series is formed by a curious bed of large-grained sand or fine conglomerate the grains being red granitic fragments. There is also a lime conglomerate. Then a band of lime in which is a fauna with a decided Carboniferous facies yet with foreign elements. In fact, the appearance is as though the Carboniferous fossils were in fragments of the Carboniferous limestone while the others were collected with the fragments and cemented together. A perfect specimen of Hemipronites cremistria with both valves was found. Awaiting the opportunity to collect added specimens the age of these beds must be left in doubt with the suggestion that they may prove the missing Permian. No fossils have so far been found in the red beds referred to the Jura-triassic.

A comparison with the section given by Captain E. C. Dutton from the Zuin plateau (Sixth Annual Report of the U. S. Geological Survey, 1885,) will show that the fragments of the Jura-triassic and Cretaceous encountered in this region are insignificant when compared to the great formations to the west, for 3150 feet are attributed to the Jura-triassic alone in that section. The work of correlation has hardly progressed far enough to make comparisons desirable.

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*NOTES ON A COLLECTION OF LIZARDS FROM NEW MEXICO.

By C. L. HERRICK, JOHN TERRY and H. N. HERRICK, JR.

The following notes are based on the collections of lizards made by the voluntary geological and natural history survey of the University of New Mexico during the season of 1898, with such additions as were possible from the collections made by the senior writer during several years previous. The area covered is chiefly within the Rio Grande valley between Albuquerque and Socorro and the area of the field-work in geology reported elsewhere in this volume. For specimens from Gallup we are indebted to Mr. Wallace Bowie, and for a few specimens from Magdalena to Mr. James Fitch. The object in presenting these fragments is simply to facilitate the prosecution of this work during the coming seasons and to give to the residents of the territory who may be willing to assist in it the basis for the recognition of the commoner species. None of our lizards are venomous and they are mostly to be ranked with the harmless, if not actively helpful, inhabitants of the plains and mountains. In many cases they are marvelously abundant, especially is this the case with the Holbrookias and smaller horned toads. The latter pass below ground in October and do not reappear till spring, while the smaller lizards may appear during the warmer parts of the day throughout most of the winter. They are, for the most part, subject to a great deal of individual and seasonal variation and many are provided with a remarkable degree of color adaptability in adjustment to the environment, so that, for example, species from the open sands are entirely different in markings and color scheme from those of more pro-

*Read before the Denison Scientific Association, December 24, 1898.

tected stations. They also have the camelion-like power of adapting themselves in a short time to the color of the background.

LACERTILIA.

The lizards may be distinguished from the recent families of reptiles by their scaly bodies, the presence of limbs, the absence of a carapace, the three-chambered heart, the fact that the jaw is not dislocatable from its cranial attachment as in snakes or, more technically, by the following characters: quadrate bone articulated with the skull, parts of the ali- and orbito-sphenoid regions fibro-cartilaginous, rami of the madible united by a suture, anal cleft transverse, copulatory organs paired.

KEY TO THE FAMILIES DESCRIBED.

I. Eyes with movable lids.
  a. Pupil elliptical, vertical; head without large plates, its skin freely movable, . . *Eublepharidae.*
  aa. Pupil round; top of head with immovable plates.
    b. A series of femoral pores.
      c. Lateral scales not abruptly smaller than the ventrals in numerous series; tongue not deeply divided, ... *Iguanidae.*
      cc. Lateral scales granular like the dorsals and smaller than the ventrals, which are in 8 longitudinal series, tongue ending in two slender points, ... *Teiidae.*
    bb. No femoral pores.
      d. Lateral scales very much smaller than the dorsal and ventral, usually hidden by a lateral fold; dorsal scales keeled, ... *Anguidae.*
      dd. Lateral scales not much smaller than dorsals and ventrals; no lateral fold; scales smooth.
        e. Scales on body flat, thin and imbricate, *Scincidae.*
        ee. Scales tuberculate, usually bony, with granular interspaces. Poison glands present, *Helodermidae.*
II. Eyes without lids; pupil elliptical, . *Xantusiidea,*

Family. EUBLEPHARIDAE.

This family is admittedly nearly related to the geckos, from which its members differ in the procœlian vertebrae and single parietal bone. The limbs are slender and the claws are retractile. The rather few species are widely distributed, the family being represented in North and Central America and in Asia. The color patterns among those widely separated species is very similar.

Coleonyx variegatus, Bd., has been found in Texas and in California and so may be expected to occur in southern New Mexico. It may be recognized by the characters of the family and the five dark brown bands crossing the yellow of the back. The eyelids have a series of pointed scales. Males have six to eight preanal pores.

Family. IGUANIDAE.

A very large family restricted to America and the islands of the Pacific with the exception of two genera from Madagascar. The species are diurnal, the eyes having round pupils and strongly developed lids. The teeth are sub-equal in size and usually conical. Femoral pores are usually present in the North American forms while often absent in those of South America. The form of the head shields is various and affords good generic and specific characters. In this paper the shield formed by the confluence of a number of plates about the parietal eye is called the interparietal and not occipital, as is done in many cases. The tympanum is distinct, except in Holbrookia. The species are generally insectivorous but many are partial to a varied diet and some seem to be strongly vegetarian. Phrynosoma and some species of Sceloporus are oviparous. From the excellent report of John Van Denburgh on the reptiles of California we take the following key to the genera likely to occur within our limits.

Synopsis of Genera of Iguanidae.

I. A low dorsal crest composed of one longitudinal series of enlarged scales, . . . *Dipsosaurus.*

II. No dorsal crest.

A. Head without spines.

a. One or more transverse gular folds.

b. Toes with a lateral fringe of movable spines, . *Uma.*

bb. Toes without spines.

c. Supralabial plates strongly imbricated; symphyseal plate smaller than the largest infralabial.

d. An ear opening, . . . *Callisaurus.*

dd. No ear opening, ... *Holbrookia.*

cc. Supralabials not imbricated; symphyseal not smaller than the largest infralabial.

e. No large interparietal plate; caudal scales small, not strongly keeled or pointed.

f. Ear without strong denticulations and neck without spinose tubercles; supercilaries imbricate; tail long and tapering, . . *Crotophytus.*

ff. Ear with strong denticulations and neck with numerous spinose tubercles on lateral folds; supercilaries not imbricate; tail scarcely longer than distance from snout to vent, . *Sauromalus.*

ee. A very large interparietal plate; caudal scales large, strongly keeled, and sharply pointed, *Uta.*

aa. No complete transverse gular fold, . *Sceloporus.*

AA. Head with large spines posteriorly, . *Phrynosoma.*

Genus. DIPSOSAURUS.

The single species of this genus, Dipsosaurus dorsalis, Bd. and Gd., has been found in the Colorado and Mojave Deserts and is abundant in the neighborhood of Yuma. It probably does not occur within our limits. It is entirely vegetarian in habit.

Genus. UMA.

The two known species of Uma are not known to occur in our region, they being, like the last and the following, desert loving animals.

Genus. CALLISAURUS.

Callisaurus ventralis, the only species, within the United

States, was said to occur in Texas as well as in the desert region of southern California and Arizona. It may therefore occur in New Mexico. Stejniger, however, denies that it occurs in either Texas or New Mexico.

Genus. HOLBROOKIA.

Unlike the related genera, this genus is devoid of external ear discs, the tympanum being covered. The dorsal scales small, uniform; head scales small, interparietal enlarged. A long series of femoral pores; two transverse gular folds, the posterior with a denticulated edge; no abdominal ribs; males with enlarged postanal plates. The genus is limited to the southwestern part of North America.

Holbrookia Maculata, Girard.

Plate XIV, Fig. 1.

Holbrookia maculata, *Girard,* Proc. Am. Assoc. Ad. Sci., 1851; Stanbury's Expedition Gt. Salt Lake; *Cope,* Proc. U. S. Natl. Mus. 1880.

var. flavilenta, *Cope,* Proc. Acad. Nat. Sci. Phil., 1883; *Stejniger,* N. A. Flora, No. 3; *Boulenger,* Cat. Liz. Btit. Mus.

approximans, *Baird,* Proc. Acad. Nat. Sci. Phila.

maculata approximans, *Van Denburgh,* Cal. Acad. Sci., V, 1897.

Description: Body depressed fusiform, head short, V-shaped in perpendicular section; nostrils on the upper surface; head plates mostly small and irregular, except the interparietal, which is large, as wide as long; one or more series of axial scales in front of the interparietal larger than the other head plates; supraocular regions covered with small granules; superciliaries strongly imbricated; middle subocular plate very large; eyelids well fringed; about six upper labials, strongly imbricated; lower labials smaller, not imbricate, separated from enlarged sublabials by a row of small scales; gulars flat, not imbricate, but becoming so on the last gular fold; ventral scales larger than the dorsals and laterals, which are granular; a lateral fold between the fore and hind limbs which are short;

femoral pores about 12 ; tail short, abruptly narrowed at about the proximal third.

Color: Upper parts gray yellow or light brown, with two or four longitudinal series of dark splotches and numerous lighter spots ; top of head like back but without definite pattern ; upper surfaces of legs marbled with brown ; throat white or yellowish, sometimes marbled with darker ; tail with a single series of spots ; under parts white or yellowish, with two or three transverse of black laterally behind the fore legs and which do not extend dorsally above the lateral fold and are sometimes edged with blue.

This little species is abundant everywhere in the Rio Grande valley and elsewhere in central New Mexico. It is extremely variable in color and adapts itself both temporarily and permanently to local color conditions. It feeds largely on plants and climbs readily.

Holbrookia Texana, (Troschel), Baird and Girard.
Plate XIV, Figs. 2-5.

Cophosaurus texanus, *Troschel,* Arch. f. Natur., 1850; Holbrookia texana, *Bd.* and *Gd.* Proc. Acad. Phila., 1852; U. S. Bound. Surv.; *Bocourt,* Miss. Sc. Mex. Rep.; *Cope,* Bul. U. S. Natl. Mus., 1880; *Boulenger,* Cat. Liz. Brit. Mus.

affinis, *Baird* and *Girard,* Proc. Ac. Phil., 1852.

Description: Body slender, head as long or longer than head and body ; head very small, V-shaped in vertical outline ; nasal openings dorsal, prominent; head plates mostly small and irrelegular except the interparietal which is not large, and a series of rather large axial plates in front of the latter ; superciliaries large and strongly imbricated ; one of the suboculars very large; eyelids fringed; about seven large imbricated upper labials ; lower labials smaller, not imbricated, bordered below by one or more series of enlarged sublabials ; gular scales flat, not imbricated ; posterior margin of the gular fold feebly denticulate ; ventral scales larger than the dorsals and laterals ; a lateral fold extending from the fore to the hind limb ; femoral pores from twelve to fourteen ; males with enlarged postanal plates ; tail slender ; hind foot very long.

Color: background above pale gray to yellow; upper surface of tail and caudal half of the back marked with transverse bands of brown; anterior part of back with circular spots especially laterally: sides in front of hind leg marked with two deep black crescentic lines extending from the lateral fold toward the median line on a bright yellow field; upper surfaces of limbs with irregular dark markings; under parts white or yellowish; under surface of tail with transverse bars of black; throat and lateral belly patches blue in the male; a dark streak along the caudal aspect of thighs.

This beautiful species has been collected no further north than Socorro where it is not rare. It ranges from northern Mexico into the adjacent states.

Genus. SCELOPORUS.

Head and body somewhat depressed, shorter than the tail; no dorsal crest; dorsal scales keeled imbricate, equal; head scales large, especially the interparietal, usually with a definite pattern; no gular fold; tympanum distinct protected by strong teeth; femoral pores present; superciliaries imbricate.

Sceloporus Poinsettii, Baird and Girard.

Plate XV, Figs. 6-8.

Seloporus poinsettiii, *Bd.* and *Gd.*, Proc. Acad. Phila., 1852; U. S. Bound. Surv.; Sceloporus torquatus, var. C. *Bocourt*; toquatus poinsettii, *Cope*; torquatus cyanogenys, *Cope*; torquatus, var. poinsettii, *Boulenger*, Cat. Liz. Brit. Mus.

Description: Head and body somewhat depressed, very broad; nasal opening near the end of the snout, on the dorsal surface and within the canthus nasalis; upper head plates smooth, convex, not imbricated, irregular; interparietal largest; frontal divided transversely, caudal portion divided into four or more unequal parts, cephalic portion divided longitudinally; supra-oculars forming two irregular longitudinal rows, seperated from the axial head plates by a continuous series of smaller scales; superciliaries large, strongly imbricated, keeled, separated from the supra-occular by an irregular series of granules and small scales, middle sub-occulars as long as the remainder of

the series, keeled; rostral plate narrow, nearly rectangular; labials low, upper and lower subequal; symphyseal plate large, pentagonal, followed by a series of plates larger than the gulars, not separated from the lower labials, the latter, however, in a double row; gular scales smooth, flat, bicuspid, strongly imbricated; those of a median portion of the belly not toothed, toward the sides first becoming bicuspid, then strongly denticulate; passing gradually into the dorsals; ear opening large, nearly vertical, protected by a small series of acuminate scales, only two of which are specially modified; scales of back broad, equal, slightly keeled, short-pointed and serrate, in longitudinal series but converging backward toward the median line; dorsals of the lumbar region, smaller than the caudal scales; scales of the sides pointing obliquely upward; no longitudinal dermal folds; a transverse gular fold behind the ear opening; upper surfaces of limbs covered with strongly keeled and long-pointed scales; scales on the posterior surfaces of thigh similar; upper caudal scales not serrate, strongly spined, spines directed obliquely outward; femoral pores varying from eleven to thirteen or more; six to ten dorsal scales equal in length to shielded part of head; number of scales from the interparietal to a line drawn through the posterior surface of thighs about 30; males with enlarged post-anal plates; tail as long as head and body.

Color: upper parts olivaceous brown, head darker; black collar in front of shoulders; distinct, nearly complete rings of dark on tail; back with dark, broad, irregular inconspicuous bands; male much darker than female; under side of throat bluish grey, in the male darker and more highly colored; bluish longitudinal bands on either side of abdomen in both sexes, merging into a dark spot in front of the thighs; under parts yellowish white; spines of upper surfaces of limbs dark-tipped.

Measurements: Total length, 215 mm.; Length to anus, 105 mm.; Length of tail, 110 mm.; Snout to ear, 26 mm.; Width of head, 27 mm.; Fore leg, 42 mm.; Hind leg, 70 mm.; Base of fifth to end of fourth toe, 20 mm.

This species has been found living upon rocks at an eleva-

tion of about 6,500 feet in the western part of the Magdelena mountains and is reported also from Socorro though no specimens are available from that place. Our specimens were kindly secured for us by Mr. James Fitch, of Magdalena. This species seems to be shy and restricted to rocky places in our range.

Sceloporus Magister, Hallowell.
Plate XVI, Figs. 9–11.

Description: Head and body little depressed, sub-cylindrical; nasal opening nearer the end of the snout than the orbit; upper head plates smooth, often somewhat convex, usually slightly imbricated; interparietal largest; frontal divided transversely, two portions sub-equal or caudal part larger; parietals and fronto-parietals not separated from the enlarged supraoculars; latter very broad as are the strongly imbricated superciliaries: middle sub-occular long, narrow and strongly keeled; rostral plate wider than high; labials long but very low, inferior longer than superior; symphyseal plate large, followed by several plates larger than the gulars, separated from the lower labials by one to three rows of narrow sub-labials; gular scales smooth, flat, bi-cuspid, strongly imbricated, as are those of the belly; ear opening large and nearly vertical, protected by a series of very long accuminate scales, four of which are specially modified and not keeled projecting backward and slightly downward; back with equal, keeled, strongly pointed scales bearing a spine on either side of the point, arranged in nearly parallel longitudinal rows; 14 rows of keeled dorsals; scales of sides ranging obliquely upward, merging gradually into the smooth ventrals. No longitudinal dermal folds; upper surface of the limbs provided with strongly keeled and pointed scales; scales on the poster surface of thighs large, accuminate, strongly keeled, and long pointed; upper caudal scales similar to the dorsals but longer pointed; femoral pores varying from 11 to 15 on each side; five to ten dorsal scales equal in length to the shielded part of the head; number of scales from interparietal to line connecting posterior surfaces of the thighs varying from 29 to 35; males with enlarged post-anal scales.

Color: back grey, yellow or brown, with indistinct mottlings of brown anteriorly; a black bar or collar in front of each shoulder; head nearly uniform; faint brownish rings on the tail; central patch of blue on throat of adult males; lateral band of blue bordered with black; a dark area in front of thighs; under parts white or yellowish.

Measurements: Total length, 194 mm.; Length to anus, 85 mm.; Lengh of tail, 109 mm.; Snout to ear, 20 mm.; Width of head, 18 mm.; Fore leg, 39 mm.; Hind leg, 54 mm.; Base of fifth to end of fourth toe, 23 mm.

Scelopus Clarkii, Baird and Girard, Proc. Acad. Nat. Sci. Phil. 1852.

Baird, U. S. and Mex. Boundary Surv., 1859; *Cope*, Proc. Acad. Nat. Sci. Phil., 1866; *Cope*, Check List, 1875. *Coues*, Synopsis of the Reptiles of Arizona, 1875. (Fig.) *Yarrow*, Check List of N. Am. Reptilia, 1882. *Stejniger*, N. Am. Fauna, No. 7. *Van Denburg*, Cal. Acad. Sci., V.

The relation between this species and Sceloporus magister, which is confessedly very close, has been discussed *in extenso*, in N. Am. Fauna, No. 7, by Stejniger, who claims that the two species are constantly distinguished by a difference in the spines guarding the ear openings; these modified spines being smaller and less acute in S. clarkii. There is said to be a difference in habit also and although the habitats overlap in southeastern Arizona, the stations affected by the two species are said to be different, S. magister affecting an arboreal life while S. clarkii is found upon the rocks. It is probably that this species will be found in the extreme south-western part of the territory.

The species extends into Mexico an unknown distance. Farther south, it is said to be replaced by S. boulengeri, which is similar to S. clarkii but has fewer femoral pores, short and broad ear spines and a very broad interparietal. S. acanthinus is said to be modification of the same type still further to the south.

Sceloporus Occidentalis, Baird and Girard. (?)

Plate XVII, Figs. 12–14.

Description: Head and body somewhat depressed; nasal openings nearer the end of snout than the orbit; upper head plates smooth, somewhat convex, somewhat imbricated; interparietal largest; frontal divided transversely, cephalic portion larger; parietals and frontoparietals separated from the enlarged supraoculars by a series of granules; latter in the single series, very broad and convex, separated from the narrow, imbricated superciliaries by a series of granules, middle suboccular long and keeled; rostral plate broader than high; labials long and low, the upper and lower nearly equal; symphyseal plate very large, followed by a row of enlarged plates on either side, which are separated from the lower labial by a single row of sublabials; gular scales smooth, flat, some of them bicuspid; strongly imbricated; ear opening of moderate size, protected in front by about three enlarged scales; back with equal, keeled, short-pointed scales in longitudinal parallel rows; about 22 or 24 rows of keeled dorsals; scales of sides ranging obliquely upward, passing gradually into the smooth ventrals; scales of the dorsal surfaces of the limbs like those of the back, those of the posterior surfaces of the thighs smooth, no longitudinal dermal folds; scales of the tail like those of the back, but larger; femoral pores 16 to 18; about ten dorsal scales equal in length to the shielded part of the head; number of scales from the interparietal to a line connecting the posterior aspect of the thighs 40 to 42; males with enlarged postanal scales.

Color: Brownish or grayish above, with a lateral light stripe on either side, crossed a zig zag line of dark brown which usually does not cross the median line but may cross the light lateral bands and merges with the darker coloring of the sides; head marked with brown, especially a transverse line connecting the supercilaries and another in front of the eyes; a dark line passing through the eyes; upper surfaces of legs marbled with dark; tail obscurely ringed with dark; lower parts light; male with two spots on the gular region, not confluent on the

median line; flanks blue, passing into black; black spot in front of shoulder.

Measurements: Length of anus, 57–55 mm.; Snout to ear, 15–13 mm.; Width of head, 12–11 mm.; Fore leg, 28–27 mm.; Hind leg, 34–32 mm.; Base of fifth to tip of fourth toe, 15–14 mm.

With the materials at hand it is impossible to discriminate S. occidentalis from S. biseriatus. The basis of separation offered by Van Denburgh in the coloration of throat, which in males of S. occidentalis said to have two dark lateral spots, while in S. biseriatus they may be confluent. He says "I have examined many hundreds of specimens of S. occidentalis and biseriatus and have not found a single male of the latter with two blue throat patches. Highly colored male of S. occidentalis are sometimes found in which the two blue patches have extended to end even merged on the median line, but by securing very young or less brilliantly colored males, there should be no difficulty in determining which species occurs in a given locality." Unfortunately he omits to say how he knew that he was dealing with a given species while determining the validity of the sole criterion. S. occidentalis is said to be the more northern species. It may be that the best plan is to accept Boulenger's suggestion and call all the phases of this exceedingly variable group varieties of S. undulatus. This form, whatever it is, is extremely abundant in the Rio Grande valley and the range of individual variation is enormous.

Sceloporus Consobrinus, Baird and Girard.

Description: Head and body little depressed, fusiform; nasal opening nearer the end of the snout than the orbit; upper head plates smooth, somewhat convex, not obviously imbricated; interparietal largest; frontal divided transversely, cephalic portion much larger than the caudal; parietals and frontoparietals separated by small granules from the enlarged supraoculars; latter broad (but not so broad as in S. magister) and separated by a number of scales from the narrow, imbricated superciliaries; sub-occular keeled; rostral plate wider than high;

internasals large labials long but narrow, the inferior larger than the superior; symphyseal plate larger than the rostral, followed by several plates larger than the gulars, separated by one row (or two incomplete rows) of sub-labials from the lower labials; gular region with scales smooth, flat, bicuspid, and strongly imbricated like those of the belly; ear opening large and nearly vertical, protected by three or four small, acute, modified scales; back with moderate-sized, keeled, simply-pointed scales in parallel rows; scales of sides ranging obliquely upward; about 45 scales in a dorsal series from cephalic plates to a line drawn through the posterior border of the thighs; transition from the lateral to ventral scales gradual; no longitudinal dermal folds; upper surfaces of the limbs with keeled and pointed scales, like those of the back; scales of the posterior surfaces of the thighs not enlarged; upper caudal scales similar to the dorsals; about 14 femoral pores; about 8 to 12 dorsal scales equal in length to the shielded part of the head.

Color: pale olivaceous brown; head darker and uniform; back with narrow whitish bands one on either side and separated by a broad area in which is a double row of dark, irregular blotches which may be edged with lighter; sides passing gradually into the white of the lower aspects; a dark line from the posterior canthus of the eye to upper angle of ear opening and thence bordering the lateral light line laterally to the tail; upper and lower labials darker than adjacent parts; limbs marbled with dark brown; tail with obscure dark rings. (The above description refers to the female, the male being more highly colored.)

Measurements: Total length, 145 mm.; Length to anus, 71 mm.; Length of tail, 74 mm.; Snout to ear, 15 mm.; Width of head, 14 mm.; Fore leg, 27 mm.; Hind leg, 41 mm.; Base of fifth to end of fourth toe, 18 mm.

This species seems not to be uncommon in the Rio Grande valley near Socorro. Collected by John Terry and Harry N. Herrick.

Sceloporus Gratiosus, Baird and Girard.

Description: Head and body somewhat depressed; nostrils opening much nearer to the end of the snout than to the orbits; uppear head shields smooth, moderately large, and slightly convex, interparietal largest; frontal usually divided transversely; parietal, frontoparietal and frontal plates separated from the supra-occulars by a series of small plates of granules; superciliaries long, wide, and strongly imbricated; middle subocular very long, narow strongly keeled; rostral plate very wide and rather high; labials long, low, and almost rectangular; below lower labials series of large sublabial plates; symphyseal arge, pentagonal; gulars small, smooth, imbricate, frequently emarginate posteriorly, about the size of the ventrals; ear opening large, slightly oblique, with an anterior armature of from four to seven accuminate scales; dorsal scales equal, keeled, pointed, and arranged in longitudinal parallel rows; scales on sides similar to those of the back, but directed obliquely upward; no longitudinal dermal folds; superior surfaces of the limbs with keeled scales; posterior surfaces of thighs with small smooth scales; ventrals smooth but usually bicuspid; caudal scales very much larger than the dorsals, heeled and strongly pointed; femoral pores varying in number from twelve to twenty; eleven to seventeen dorsal scales equal in number to the shielded portion of the head; scales in the longitudinal row from parietal plate to a line connecting the posterior aspects of the thighs varying from 45 to 66; males with enlarged postanal plates.

Color: above, brown, olive or bluish or greenish gray; with one dorsal and two lateral series of closely set brown spots on each side, spots sometimes more or less confluent, forming longitudinal bands separated by narrower bands of the lighter ground color; tail usually with trace of darks rings; males with a blue spot, sometimes bordered with black, on each side of the belly; throat more or less washed with blue which has a tendency to form narrow oblique lines.

This species is closely related to S. consobrinus, but is smaller. It occurs in the mountains of California, Utah and

Nevada and will doubtless be encountered in the northwestern parts of New Mexico.

After careful comparison of descriptions by various authors we incline to believe that this but a smaller mountain-loving race of S. consobrinus. One of our specimens of the latter species is but 130 mm. but otherwise resembles the types.

Genus. PHRYNOSOMA.

The horned toads are among the most characteristic of lizards and form a rather compact American group which are not to be confused with any other. Their bizaire spiny, disc-like bodies and short horned heads which they know well how to use in the defensive and even in offensive struggles are eminently characteristic. The plates of the head and body are heterogeneous and tend to assume the spinous form while the existence of strong bony spines from the back of the head is a universal character. The tympanum is distinct and may or may not be covered with scales. There is a transverse gular fold and usually a series of peripheral spines along the lateral margins of the body. Femoral pores are present. The tail is short as are the legs. The digits have keeled lamellae below. Lateral teeth subcoincal or indistinctly tricuspid ; no pterygoid teeth. No abdominal ribs. A large sternal fontanelle. Other osteological characters may be gathered from the figures.

In our region (eastern New Mexico) we have been able to distinguish but three species though there is a considerable range of variation which may serve to invalidate some so-called species. These animals are essentially insectivorous and sluggish and rely upon their spinous armature for protection as well as upon their very considerable power of modifying the color of the skin to conform to the color of the station. This power is due to the capacity of the chromatophores to alter their form in obedience to nervous stimuli of varying kinds.

They protect themselves from the extremes of heat and cold by burying themselves in the earth. We have never been able to observe that they construct burrows but they sink into the sand in such a way as to completely cover the body and

may be seen after a cold night imerging from the sauce-like depression so made.

Like many others we long regarded the statement that these animals sometimes discharge a qauntity of blood from their eyes when disturbed as a fable. Upon a single occasion however we have had an opportunity to verify this statement. So far as we could discover the animal was not injured and we have handled others much more roughly without such a result but in this case (P. cornutum) a large drop of a red fluid was thrown out from the eye and moistened its head as well as the hands of the intruder.

Although the most peaceful of animals, the horned toads defend themselves with energy. The writer once witnessed a contest between two large lizards (Crotophytus) and a very large specimen of P. douglassii. The toad threw himself into the most amusing posture of defense by kneeling down with the legs of one side while standing on tip toe with the opposite set and thus presenting the shield-like dorsal surface to the enemy. With a single opponent these tactics succeded well and the lizard received some shrewed thrusts with the powerful horns, but when there were two foes it was easy for one to take advantage of the weaker side and sieze the toad in the soft region under the neck where he hung with a grip not to be shaken off.

KEY TO THE GENUS PHRYNOSOMA.

The following key is largely a compilation from various sources and we suspect that there may be synonyms or at most geographical races among the species enumerated. It is hoped that the table such as it is may nevertheless be serviceable.

A. Nostrils opening on or near the lines connecting the supra-orbital ridges with the end of the snout (canthi rostrales).

a. Gular scales small, nearly equal in size; a series of enlarged scales below, but not larger than, the lower labials.

b. Head spines short (variable); occipitals shorter than the transverse diameter of the eye ball. *P. douglassii.*

bb. Head spines moderately large, occipitals as long as the transverse diameter of the eye; gular scales perfectly smooth, . . *P. orbiculare.*

aa. Several longitudinal series of enlarged pointed gular scales; a series of large spinose plates below the lower labials; head spines long.

b. Gular scales spinose.

c. Head shields convex and almost smooth. *P. blainvillii.*

cc. Head shields flat, with numerous ridges and granulations, ... *P. frontale.*

bb. Gular scales feebly keeled.

c. Occipital spines extend upward and outward. . . . . *P. boucardii.*

AA. Nostrils opening in the line of the canthi rostrale or slightly above; several longitudinal series of enlarged gular scales; a series of very large bony shields below the lower labials.

a. Occipital spines directed obliquely upward, like the temporals; ventral scales smooth, . *P. coronatum.*

aa. Occipital spines vertical, erect; ventral scales keeled. . . . . *P. asio.*

AAA. Nostrils pierced within the canthi rostrale; gular scales small, equal or with one series of enlarged ones on either side.

a. Tail longer than the head.

b. Head bordered posteriorly by a series of contiguous large spines, of which four are occipital. *P. regale.*

bb. Two occipital spines larger than the other head spines, with an interval between their bases and those of the temporal.

c. Enlarged dorsal tubercles spinose, erect; tympanum naked, ... *P. cornutum.*

cc. Enlarged dorsal tubercles flat, or feebly raised; tympanum covered with scales; occipital spines as long as the horizontal diameter of the orbit; two or three series of peripheral spines; 18–20 femoral pores, . . . *P. platyrhynus.*

ccc. Enlarged dorsal tubercles flat or feebly raised; tympanum covered with scales; occipital spines shorter than the transverse diameter of the eye; peripheral spines a single series or nearly absent; 6–12 femoral pores; more than three sublabials enlarged,. . . . *P. platyrhynus.*

cccc. One series of peripheral spines; 7–10 femoral pores; only three sublabials enlarged. . . . . *P. goodei.*

bbb. Two occipital spines not longer than the longest temporals, ... *P. modestum.*

c. Tail not longer than head.

d. Occipital spines a little larger than the temporals. . . . *P. braconnieri.*

dd. Occipital spines much smaller than the temporals. . . . . *P. taurus.*

The following probable synonyms are indicated: P. planiceps is a variety of P. cornatum., P. brevirostris is P. douglassii., P. ornatissimum is P. douglassii., P. solaris is P. regale.

Sp. 1. ***Phrynosoma Douglassii,*** Bell.

Plate XVIII, Fig. 15.

This is the common species in she mountains and upland mesas in northern New Mexico.

Description: Nostril opening on the canthi rostrales; gular scales small, near equal in size; a series of enlarged sublabial scales which are not much larger than the infralabials and are separated by several rows of granules. Infralabials (in a large specimen) 16 on a side, increasing toward the angle of the mouth and there ending in a large spine; sublabials 9 on a side; supralabials not enlarged and passing laterally into small granular scales; head spines rather small, about equalling the transverse diameter of the orbit; four temporals, one occipital and one postorbital spine on a side; other head scales small and irregular, roughened with ridges and granulations; one or two gular folds; tympanum not covered with scales; back covered with sharp, keeled, tubercular spines, which are irregularly distrib-

uted; a single row of sharp spines along the sides; tail with a lateral and two dorsal rows of spines; scales on the breast, belly and proximal aspect of the tail smooth, but those on the terminal part of tail keeled; in a large specimen the latter bands, as well as the blotches of dark on the back often indistinct; lower surfaces pure white.

Measurements: Length of anus, 40 mm.; tail, 20 mm.; snout to eye, 10 mm.; width of head, 16 mm.; length of occipital spine, 3 mm.; fore leg, 25 mm.; hind leg, 35 mm.; base of fifth to end of fourth toe, 10 mm.

Sp. 2. *Phrynosoma Cornutum,* (Harlan) Gray.

Plate XIX, Fig. 16.

This seems to be the commoner form in the valley of the Rio Grande.

Description: Head as broad or broader than long; nostrils opening the canthi rostrales; tympanum naked; gules scales keeled, with a longitudinal series of enlarged pointed scales on either side of neck; gular folds several, irregular, a series of very large projecting sublabial scales; infralabials head spines large, the occipital being much larger than the three temporals and directed obliquely upward and outward; interoccipital and postorbital present.

Back with very large erect spinose tubercles, the longest of which form a series of three or four on either side the vertebral line; two lateral series of spines of which the upper are longest; pectoral and ventral scales more or less distinctly keeled; femoral pores twelve on a side not extending upon the preanal region; no enlarged postanal scales. The body is one and a half times as long as the tail. Scales of head pustulose or longitudinally striate, spines ribbed.

Dorsal surface of head isabelline brown, mottled with white with two black cross bands between the canthi rostrales, a band from the eye to the angle of mouth, another black band from eye to temporals, about the mouth and cheeks ochraceous brown; under parts of head mottled with black as also the lateral margins of body below; dorsal surface with 4 longitudinal

rows of dark spots edged with lemon yellow, bright yellow patch on shoulder; narrow white median dorsal line; 66 rows of scales on belly; long series of femoral pores nearly meeting in front of anus; two groups of slender spines behind the tympanum.

There are four rows of black spots on the back; each spot bordered by strips of white and yellow; space between the spots ocheraceous; tail with six double rows of black spots; underneath white often mottled with numerous black splotches.

Measurements of large individuals.

Length to anus,	100 mm.	80 mm.	42–100 mm.
Length of tail,	31 "	30 "	17– 40 "
Snout to ear,	28 "	20 "	10– 21 "
Width of head,	30 "	24 "	12– 27 "
Length of occipital spine,	4 "	2 "	1– 2 "
Length of fore leg,	42.5 "	32 "	18– 35 "
Length of hind leg,	56 "	43 "	23– 45 "
Base of fifth to end of fourth toe,	14 "	12 "	7– 15 "

Coloration of specimen from San Pedro mountain at 7000 feet. Upper surface of head mottled with brown and white; six pairs of vandyke to umber brown blotches on neck and body, the two middle pairs double as by confluence of two, spots bordered behind by a dark band shading into brown, this still bounded posteriorly by a narrow band of brilliant orange; intervals between spots irregularly shaded with orange, yellow and brown; numerous white spots on the side; irregular gray bands on either side the median line; tail with seven dark bands, belly burnt sienna with numerous small dark spots, whitish on sides with brown bands and spots.

Sp. 3. *Phrynosoma Platyrhynus*, Girard.
Plate XX, Fig. 18.

This species is excessively abundant in the valley of the Rio Grande and elsewhere at lower levels in the eastern part of the territory. It is rarely seen of a large size and is greatly exposed to the attacks of its enemies though it possesses the power of changing color to a greater extent than the others.

Description: Nostrils opening above the canthi rostrales; gular scales small, granular; one gular fold; a series of large, spinose sublabial scales which increase posteriorly; infralabials not separated from sublabials (in small specimens at least) by a series of scales but the two series in juxtaposition; two groups of weak spines on either side of neck; head spines rather short, consisting of from five to seven temporals, one occipital and postorbital; three scales in front of the occipital larger than the remaining head scales which are roughened with granulations and ridges and, except those in front of the occipital and temporal spines nearly flat.

Back, tail and upper surfaces of the limbs covered with scattered, slightly elevated, keeled, tubercular scales; one series of peripheral scales which disappears behind or is obsolescent; tail edged with small spines; scales in front of arm large, pointed, strongly keeled; those on breast, abdomen and proximal part of tail smooth; tympanum covered with scales; femoral pores nine on a side, invading the preanal region; males with enlarged postanal plates.

General color above, gray, yellowish brown, etc., variously marbled with slaty, brown or blackish; a large dark area on either side of the neck often extending back to in front of hind legs, tail transversely banded.

Genus. UTA.

Head and body moderately depressed and shorter than the tail; tympanum distinct; no dorsal crest; dorsal scales small, keeled, either uniform or heterogeneous; head plates large, the interparietal being larger than the ear opening; one or more transverse gular folds, the anterior one with denticulated edge; labials not imbricated; superciliaries imbricated; femoral pores present; lateral teeth tricuspid; no pterygoid teeth; a large sternal fontanelle; no abdominal ribs; males with enlarged postanal plates. This is a genus confined to Mexico and the southwestern states of the Union.

KEY TO THE AMERICAN SPECIES.

I. Dorsal scales uniform, larger than those of the flanks,
  a. Dorsal scales not imbricate, smooth, a narrow black band from shoulder to shoulder above, ... *U. mearnsi.*
  aa. Dorsals imbricate, keeled, no black band from shoulder to shoulder, a round blue spot behind the axilla, ... *U. stanisburiana.*

II. A band of six or eight longitudinal series of equal enlarged scales along the middle of back.
  b. A lateral line of special scales, . *U. ornata.*

III. Dorsal scales heterogeneous.
  c. Slender, tail more than twice as long as head and body, enlarged dorsals sub-equal, *U. gratiosa.*
  cc. Stouter, tail less than twice as long as head and body, largest dorsals in four series, *U. symmetrica.*

Uta Ornata, Baird and Girard.

Uta ornata, *Bd.* and *Gd.*, Proc. Acad. Sci. Phila., 1852; U. S. Mex. Bound. Surv.; *Boulenger*, Cat. Liz. Brit. Mus.

"This species may be distinguished from U. stanisburiana, of which it has the general appearance, by a dorsal space covered with five or six rows of scales larger than those on the sides of the body. Along the middle of the sides there exists one row of small scutellae imitating the lateral lines of fishes. The ground color is reddish brown, with transversely elongated black patches all along the upper part of body and tail. The belly is unicolor in the female while it is blue in the male." The range is said to be from Texas to California. It has not been encountered by our collectors.

Uta Stanisburiana, Baird and Girard.

Plate XXI, Fig. 19.

Uta stanisburiana, *Bd.* and *Gd.* Proc. Acad. Nat. Sci., Phila., 1852; Stanisbury's Exp. Gt. Salt Lake, 1853; *Boulenger*, Cat. Lizards Brit. Mus.; *Van Denburgh*, Bul. Cal. Acad. Sci. V.

Uta elegans, *Yarrow*, Proc. U. S. Natl. Mus. 1882.

Description: Head and body depressed; head truncately pointed in front; head plates flat smooth; interparietal largest; frontal plate divided transversely, followed in a cephalic direction by an irregular series of enlarged plates; three to five supraoculars enlarged and separated from the frontals by small granules; superciliaries imbricate, few, projecting; central subocular large keeled; rostral and supralabials long and low; the other plates of the upper surface small or granular; symphyseal plate rather small, followed on either side by larger smooth plates which are separated from the infralabials by one to three series of sublabials; gular region covered with small, smooth, nonimbricating scales; gular fold with a series of projecting spines; tympanic opening with an armature of three enlarged spines; lateral dermal folds present; back with keeled scales nearly uniform in size but graduating into those of the side, on the neck and sides granular scales; scales of tail large, keeled and pointed; femoral pores from twelve to seventeen.

Color: Upper parts with a ground color of brownish or yellowish gray densely spotted with darker and lighter; a more or less distinct light band on either side of the back, most distinct anteriorly; the small spots of the upper surface tend to be blue or green and often give to the animal a prevailing tone of that color; tail often with dark rings; upper surfaces of limbs spotted like the back; toes of hind feet with dark bands; under parts light, variously marbled with dark; throat blue with light spots; an irregular blue spot behind the fore leg which is surrounded by a light band; usually a brown spot in front of the shoulder; sides marked with large light spots.

This graceful species is abundant in the Rio Grande valley at Socorro and further north. It is active and restricted to the ground.

Genus. CROTOPHYTUS.

Head and body depressed or sub-cylindrical, much shorter than the very slender tail; no dorsal crest; a gular fold; tympanum present; all the head plates small; labials not imbricate; dorsal scales small and nearly uniform; a long series of femoral

pores; males with enlarged preanal plates; lateral teeth tricuspid; pterygoid teeth; no sternal ribs; no sternal fontanelle. These large and very active lizards occur in the southwest states and northern Mexico. They are predaceous and even cannibal in their habits. Two species are known to occur in New Mexico.

Crotophytus Wislizenii, Baird and Girard.

Crotophytus wislizenii, *Bd.* and *Gd.* Proc. Acad. Sci., Phila., 1852; Stanisbury's Exp. Salt Lake, 1853; *Baird*, Mex. Bound. Surv. 1859; *Boulenger*, Cat. Liz. Brit. Mus.; *Van Denburgh*, Bul. Cal. Acad. Sci. V.

Crotophytus gambelii, *Baird* and *Girard*, *l. cit.*

Description: Body slender and strong; head large, depressed and broad behind; head plates small, larger toward the snout; snout convex; three to five longitudinal rows of shields between the supraocular regions; nostrils nearer the end of head than the orbit; superciliaries small, imbricate; a long subocular plate; rostral plate very low; supralabials of nearly equal size; lower labials somewhat larger than the upper, bordered below by several series of small plates larger than the gulars; symphyseal plate large; tympanic opening large oblique; one strong gular fold with sometimes two additional ones; back and sides covered with small granules merging into the larger scales of the belly; latter imbricate and sometimes keeled; irregular lateral dermal folds; tail cylindrico-conical, more than twice as long as the head and body; males with enlarged postanal plates.

Color: Upper parts browish gray, the head darker, with creamy white lines surrounding the orbits and in the supraocular regions and the snout; back crossed with alternating light lines; between each pair of which a round spot of brown; the proximal part of tail like the back, the distal part ringed with dark; upper surface of limbs marbled or spotted. With age the spots on the back break up, the bands disappear or become more marked and the whole color fades. No two specimens are exactly alike. There is a change during the breeding season, especially in the females.

This species seems to occupy the entire territory at suitable stations but does not ascend into the mountain canons, where its place is taken by C. Collaris. So far from being sluggish, we have found it the most active and wary of our lizards. It will fight viciously and devours other species of lizards and upon occasion, young of its own species.

Crotophytus Collaris, Say.

Plate XXII, Fig. 20. Plate XXIII, Fig. 21.

Agama collaris, *Say,* Long's Exped. Rocky Mts., Harlan. Med. Phys. Res.

Crotophytus collaris, *Holbrook,* N. A. Herpetology; *Wiedman,* Nova Acta, 1865; *Baird,* Pacific R. R. Surv. Pl. XXIV; *Cope,* Proc. Acad. Phila., 1866; *Boulenger,* Cat. Liz. Brit. Mus.

Description: Head large, depressed, much swollen posteriorly, especially in the males; body fusiform; tail long and terete; legs very long and strong; plates of head all small, two or more series between the granules of the supraocular regions; nostrils large and opening laterally; superciliaries small and imbricate; supralabials of about equal size; a large subocular plate; ear opening large, oblique, without prominent armature; symphyseal plate large, followed by two short rows of somewhat enlarged plates; one or two well-developed gular folds; back and sides covered with small granules; ventral region with larger scales; femoral pores from sixteen to twenty-two.

Color: Upper surfaces olive or browish gray, quite variable and variously spotted and barred with lighter color; two intensely black transverse shoulder bands which do not meet above, the anterior one being interrupted by a V-shaped sepia band on the nape; under parts white, the throat and sides mottled with darker; tail near the end with dark rings. The form living in the mountain canons seems to be darker than that occuring on the upland mesas and the spots are larger and interrupted by transverse bars. The following description of a living specimen illustrates a common type of coloration:

Head above light brownish gray irregularly bloched with sepia; about seven blotches of orange red back of ear; band of

coral red in scapular region; first pair of scapular bands of black separated above by a V-shaped band of sepia; back sepia gray with small yellowish white spots; upper aspects of legs greenish; upper surfaces of hand and fingers yellow three or four spots of coral red on sides; hind legs of lighter color than back with numerous spots of sepia brown; sides of thighs yellowish green; tail ringed with alternate bands of slate color and sepia; under parts white with pale brown spots on under surface of head.

This species is not found in the immediate valley of the Rio Grande, or, if at all, very rarely, but is a resident of the lower parts of the mountain canons and the mesas adjoining. In habits it is similar to the preceding species. It is a beautiful and sprightly animal. How the C. baileyi, Stejniger is to be distinguished from this common form we are unable to say at this writing.

Family. Anguidae.

Tongue composed of two distinct portions, a principal posterior part covered with villiform papillae, and a small anterior portion, which is thin, emarginate and retractile into the basal part. The body is protected by bony plates underlying the scales, the latter being imbricated and tuberculate. An occipital plate is present. The teeth are variable and bear some resemblance to those of the Gila monster. Skull with distinct nasals, single parietal. Abdominal ribs absent. Limbs sometimes rudimentary. This family is most abundantly represented in Central America and the West Indies but is represented by the slow worm of Europe and by a few closely allied species in North America.

Genus. Gerrhonotus.

Limbs well-developed, pentadactyl; lateral fold present; scales squarish or rhomboidal, forming transverse series; eye large with a round pupil; no femoral pores or enlarged postanal plates; ear opening distinct; no gular fold. A group of closely allied species of this genus occupies the entire western coast of North America, G. Cœruleus (G. scincicaudata) being the type.

Boulenger says this species extends as far east as Texas and also describes G. kingii from Deming in southern New Mexico. The latter is regarded by Dr. Gunther as a variety of G. cœruleus. The following description is taken from Van Denburgh in part.

Gerrhonotus Scincicaudata, Skilton.

Description: Body long and rather slender, with short limbs and very long tail; head pointed, with flattened top and nearly vertical side, temporal region often swollen in old specimens; rostral plate rounded in upper outline, preceded by a pair of small internasals, a pair of small frontonasals, very large azygous prefrontal, a pair of large prefrontals, a long frontal, a pair of frontoparietals, two parietals separated by an interparietal, a pair of occipitals, and (usually) a single interoccipital; two series (of 5 and 3) supraocculars and a series of small superciliaries. Upper labials much rarge than lower, below the latter two series of large sublabial plates, lower larger; gular scales smooth and imbricate; scales on the upper surfaces large rhomboidal, strongly keeled, arranged in longitudinal and transverse series; about 14 longitudinal series of dorsals and number of transverse series to back of thighs from forty-one to fifty-two. A band of granules under the lateral folds; ventral plates about the size of dorsals, imbricate, smooth, the grayish or brownish color of the back crossed by from nine to sixteen continuous irregular dark bands; lower parts white or yellowish with brownish or grayish suffusions.

G. knightii is said to differ in having only six or eight of the dorsal series of scales keeled. It will require further study to determine the value of this distinction.

(Family. ANNIELLIDAE.)

The student should be alert for the discovery of subterranean species of this family which, so far as now known, is confined to California. The body is cylindrical and snake-like and the external limbs are absent.

Family. HELODERMATIDAE.

The Gila monsters are the only lizards with venom-secreting glands but they are fortunately so sluggish as to rarely strike even when disturbed. They may be recognized by their large size, tubercular skin and snake-like dentition.

Genus. HELODERMA.

Characters of the family.

Heloderma Suspectum, Cope.

Description: Large, heavily set, clumsy in form, with short legs and tail; nostrils large, opening laterally between three plates; eye small; ear opening large oblique; rostral and symphyseal plates large; a pair of internasals; three pairs of plates behind the symphyseal; gular region with the small tubercles passing into the plates of the belly; upper parts covered with smooth convex tubercles, separated by granules, lateral tubercles passing into the squarish plates of the belly; a pair of enlarged preanal plates.

Color: Upper parts variously and irregularly marked with dark brown and salmon color; tail sometimes ringed; belly orange or salmon, with tessalted markings of brown.

The Gila monster probably occurs in this territory only in the southwestern portion.

Family. TEIIDAE.

New world lizards related to the true lizards of Europe (Lacertidae). Head shields free from the cranial ossifications; nasals double, frontal are parietal single; tongue slender and ending in two smooth points; head covered with large, regular plates; ear opening and eyelids usually present; femoral pores may be present. A very large family represented within our limits by a single genus.

Genus. CNEMIDOPHORUS.

Four pentadactyl limbs; head plates large; two frontoparietal plates; back and sides covered with small uniform granules; ventral plates large and serially arranged; eye lids and ear

openings present, pupil round; two or more gular folds; femoral pores numerous.

Cnemidophorus Sexilieatus, Gray.

Plate XXIV, Figs. 23, 24.

Description: Slender, agile; head nearly flat above, with nearly vertical sides; snout slender; rostral plate large, high, triangular; nostrils opening within the large nasal plates which are partly enveleped by the rostral; posterior nasal nearly quadrangular, articulating with the anterior nasal, first, second, and third labials, loreal, frontal, and prefrontal plates; four enlarged supraoculars, the two in the middle largest, all of them separated from the superciliaries by a row of granules; superciliaries not imbricated, the anterior two large; supraoculars separated from parietals and frontoparietals by granules; occipitals in two or more irregular transverse bands; about five superior and six inferior labials to middle of eye; inferior labials larger than the upper; sublabials very large, connected with the symphyseal by a large azygous plate, separated from the lower labials by three or four large plates and a short series of granules in front of them; intermandibular region of throat with larger scales than the throat behind the ears to the first gular fold, behind the latter larger scales merging into those of the throat; ventral scales large, in eight longitudinal rows; upper surface with small equal granules; ear opening large, semicircular; external aspect of upper arm and cephalic aspect of fore arm with enlarged scutes; *ventral aspect of fore arm with a patch of enlarged scales below the elbow;* scales of ventral aspect of hind legs very large; *femoral pores from 16 to 18;* scales of tail strongly keeled; about three enlarged preanal scales.

Color: Above dark olive brown, passing into clear olive on the head and greenish olive on the tail; back marked with three narrow, distinct yellowish white lines on either side and sometimes a faint median stripe on the median line, the latter more distinct anteriorly; upper surfaces of limbs faintly marbled; sides of head and under parts immaculate.

Only a few specimens of this species, which is referred to

C. sexlineatus only doubtfully have been found among the numerous individuals of the next and nothing can be said of its range or habits. It is true that it seems to vary in the direction of C. undulatus but the forms seen are easily distinguished from that species.

Cnemidophorus Undulatus, Hallowell.

Plate XXIV, Fig. 22.

This is perhaps the commonest lizard in the Rio Grande valley and is everywhere in evidence. It differs from the preceding species in the absence of the patch of enlarged scales on the under aspect of the fore arm and in the colors. The back is marked by from seven to nine wavy dark bands which, in the older individuals, break up into irregular blotches to the almost entire suppression of the longitudinal arrangement; the sides of the head are distinctly marked with dark spots but the spots on the throat are small and scattering; head and tail olive. We have not seen typical specimens of C. tigris but they no doubt occur and will be recognized by the almost entire absence of the black markings on the sides of the head and a suffusion of gray on the throat. The color of the back is more minutely broken up.

Family. SCINCIDAE.

Tongue slightly notched at the tip; head covered with large regular plate scales on body and tail of moderate size, imbricate, supported by bony plates; eyelids present; pupils round; dendition pleurodont; no femoral pores.

Genus. EUMECES.

All the scales are thin, smooth and imbricate. There is a distinct ear opening and the gular and lateral folds are absent, limbs pentadactyl; nostril penetrating the nasal plate; digits not denticulated laterally. The skinks are of world-wide distribution and three species at least have been reported from New Mexico but as we have but once encountered a representative and have no authentic material it seems best to reserve the mention of these till material shall have been collected. It is to be

sought in moist places as under stones near springs and in deep woods.

DEFINITION OF TERMS.

Azygous.—Not paired.

Canthus rostralis.—The ridge from above the eyes to the extremity of the snout.

Femoral pores.—Gland openings along the lower surface of the thighs.

Frontal plates.—One or more plates on top of the head between the supra oculars.

Frontoparietals.—Plates on top of head between the parietals and the frontal.

Gular fold.—Fold of skin crossing the throat.

Gular scales.—The scales of throat.

Infralabials.—Scales of lower lip.

Internasals.—Plates of snout behind the rostral.

Interparietals.—The plate on top of head in which is the pineal or parietal eye.

Labials.—Scales of the edge of lip.

Occipitals.—Plates behind the parietals and interparietal.

Parietals.—Plates on either side of the interparietal.

Rostral.—Plate on end of snout.

Sublabials.—Plates below the lower labials.

Superciliary.—Plates on upper aspect of orbit of eye.

Supraocular.—Scales over the eye mesally of the superciliaries.

Symphyseal.—Scale at tip of lower jaw.

EXPLANATION OF FIGURES TO ARTICLE VI, VOL. XI.

Fig. 1. Holbrookia maculata.
Fig. 2. Holbrookia texana.
Fig. 3. Holbrookia texana, top of head.
Fig. 4. Holbrookia texana, side of head.
Fig. 5. Holbrookia texana, anal armature of male.
Fig. 6. Sceloporus poinsetii.
Fig. 7. Sceloporus poinsetii, ear armature.
Fig. 8. Sceloporus poinsetii, top of head.
Fig. 9. Sceloporus magister.
Fig. 10. Sceloporus magister, top of head.
Fig. 11. Sceloporus magister, ear armature.
Fig. 12. Sceloporus occidentalis.
Fig. 13. Sceloporus occidentalis, top of head.
Fig. 14. Sceloporus occidentalis, anal aamature of male.
Fig. 15. Phrynosoma douglassii.
Fig. 16. Phrynosoma cornutum.
Fig. 17. Phrynosoma, position of nasal opening.
Fig. 18. Phrynosoma platyrhynus
Fig. 19. Uta stanisburiana.
Fig. 20. Crotophytus collaris.
Fig. 21. Crotophytus collaris.
Fig. 22. Cnemidophorus sexilineatus, genital plates of male.
Fig. 23 Cnemidophorus sexilineatus.
Fig. 24. Cnemidophorus sexilineatus, ventral aspect of forearm.

ERRATA.

The authors of the article on Lizards of New Mexico do not wish to be held responsible for the fact that the specific names in the titles are capitalized but confess to the comma seperating the specific name from the authority. In explanation of the latter, in spite of various usage and authority for the omission of the point, we preferred to obey the unambiguous dictates of rhetoric rather than the divided and arbitrary authority of zoologists.

On page 126, line 2, instead of Scelopus, read Sceloporus.
On page 145, line 3, instead of Sexilieatus, read sexilineatus.
On page 146, line 1, instead of sexlineatus, read sexilineatus.
Plate XVI, instead of MAJISTER read MAGISTER.

Bulletin, Denison University. Vol. XI, Art. IV., 1898.

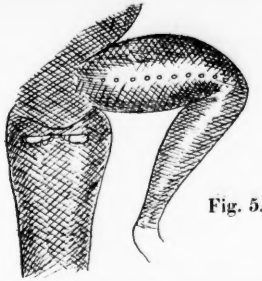

Fig. 5.

Fig. 1.

Fig. 2.

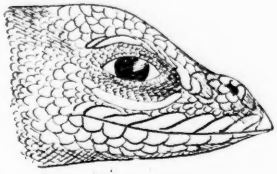

Fig. 4.

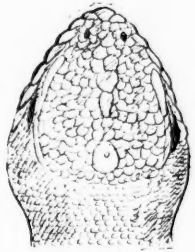

Fig. 3.

1. HOLBROOKIA MACULATA. 2. HOLBROOKIA TEXANA.

Fig. 6.

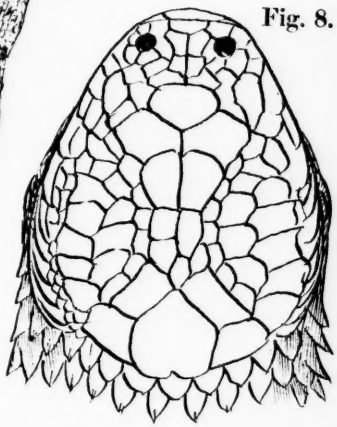

Fig. 8.

Fig. 7.

HERRICK—Lizards of New Mexico.

SCELOPORUS POINSETTII.

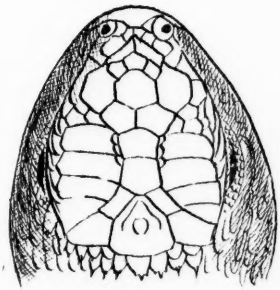

Fig. 10.

Fig. 11.

Fig. 9.

SCELOPORUS MAJISTER.

Fig. 12.

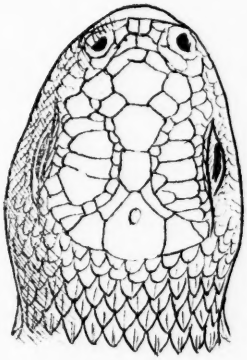

Fig. 13.

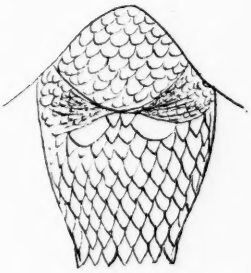

Fig. 14.

HERRICK—Lizards of New Mexico.

SCELOPORUS OCCIDENTALIS.

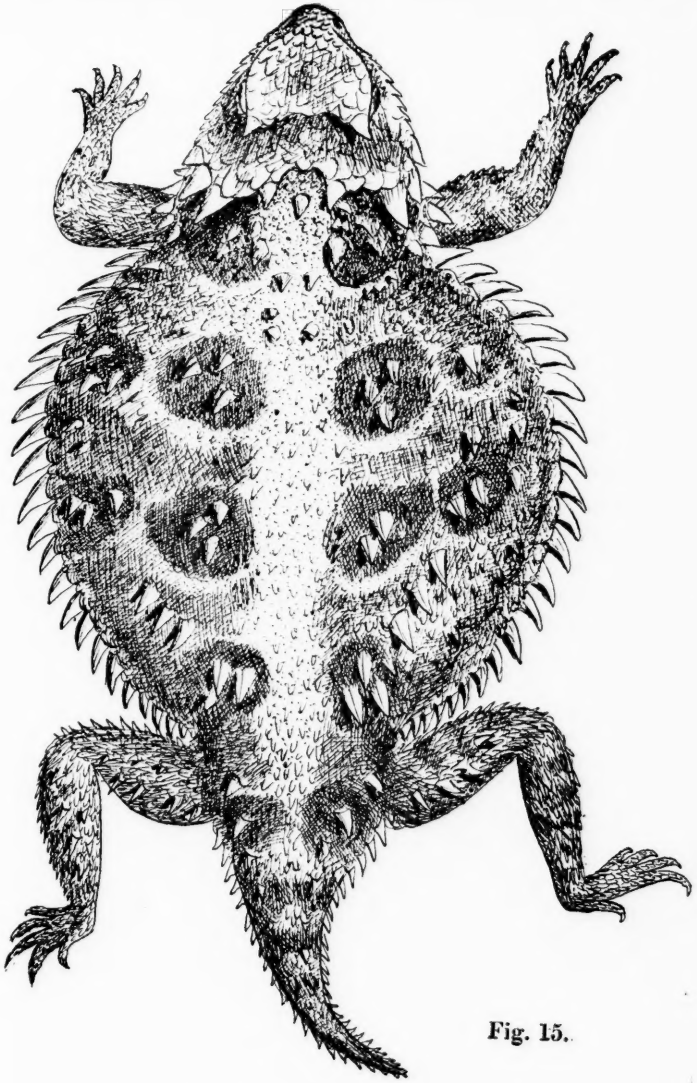

Fig. 15.

HERRICK—Lizards of New Mexico.

PHRYNOSOMA DOUGLASSII.

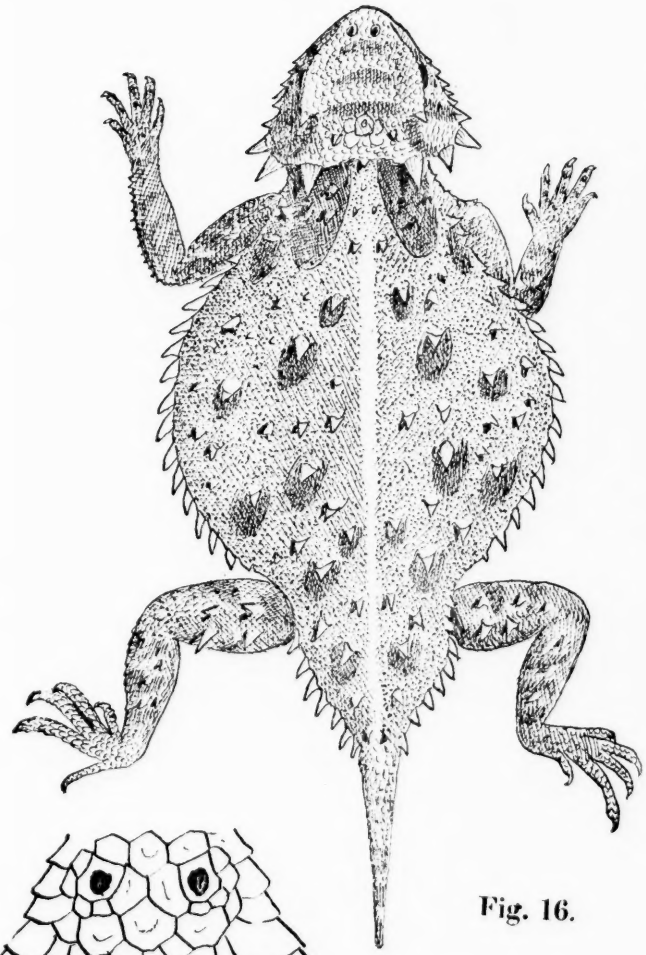

Fig. 16.

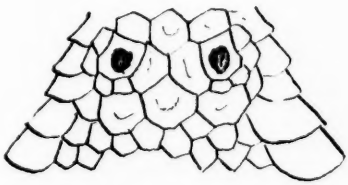

Fig. 17.

HERRICK—Lizards of New Mexico.

PHRYNOSOMA CORNUTUM.

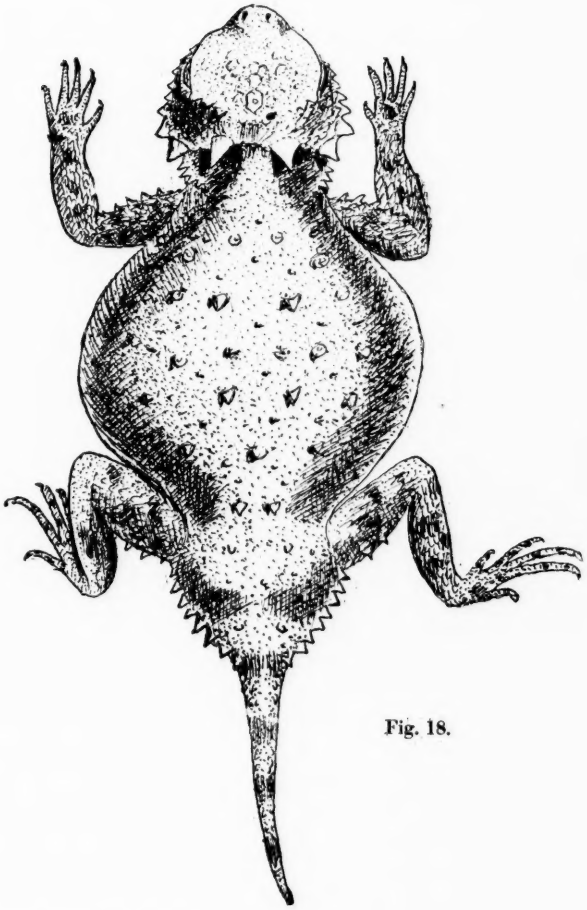

Fig. 18.

PHRYNOSOMA PLATYRHYNUS

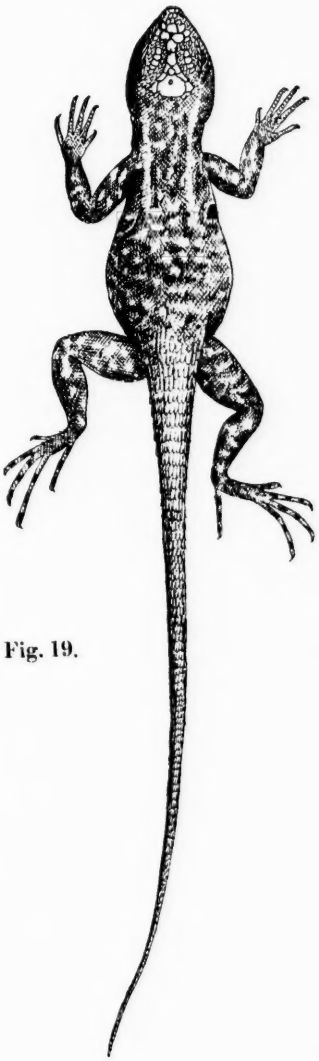

Fig. 19.

UTA STANISBURIANA.

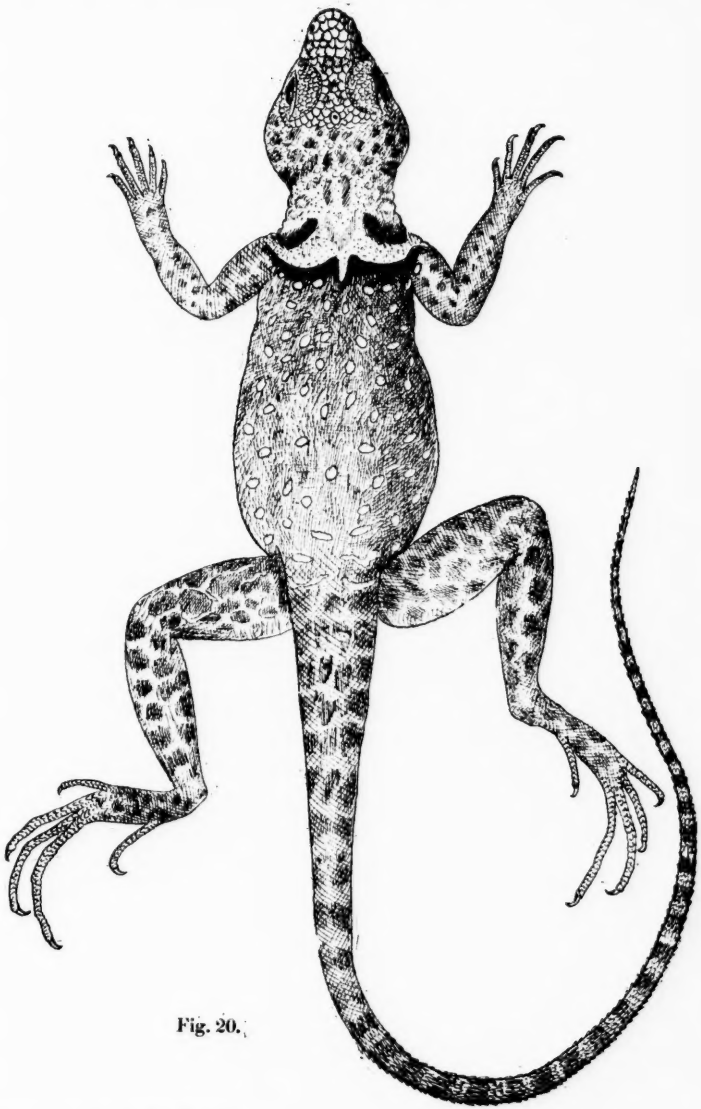

Fig. 20.

HERRICK—Lizards of New Mexico.

CROTOPHYTUS COLLARIS.

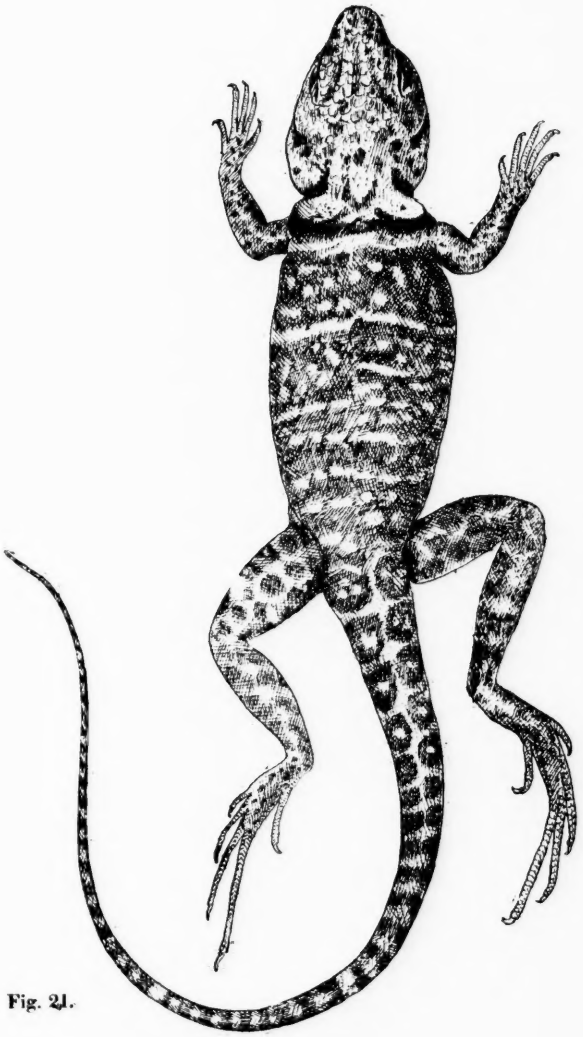

Fig. 21.

HERRICK—Lizards of New Mexico

CROTOPHYTUS COLLARIS.

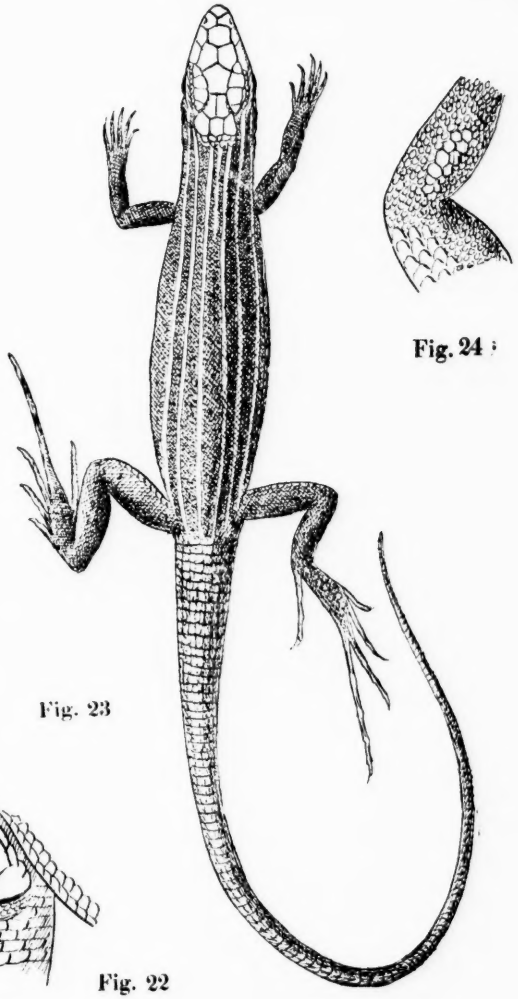

Fig. 24

Fig. 23

Fig. 22

HERRICK—Lizards of New Mexico.

CNEMIDOPHORUS SEXILINEATUS.